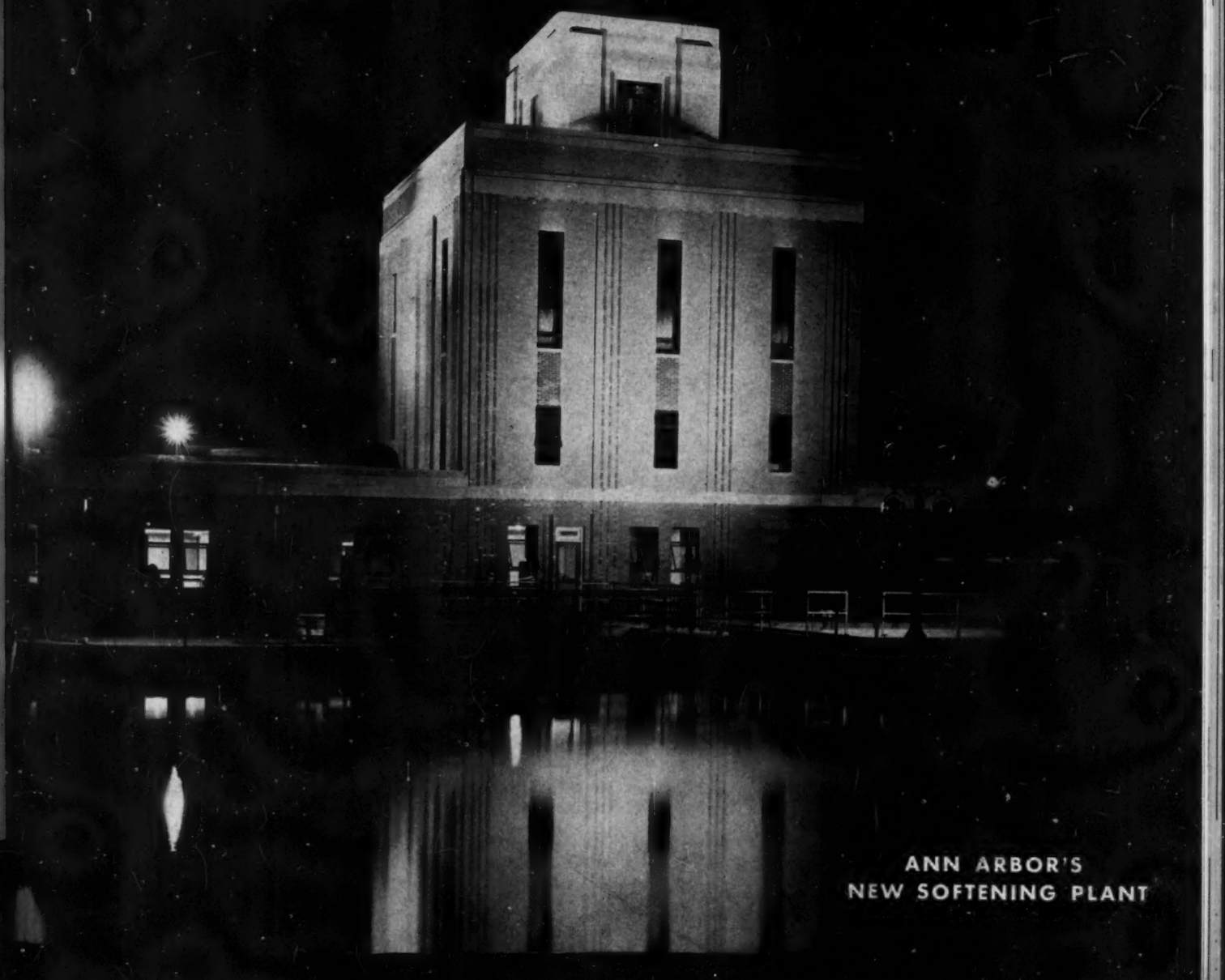
WATER WORKS & SEWERAGE



ANN ARBOR'S
NEW SOFTENING PLANT

MEN AT WORK constructing a cast iron line are building for the ages. Generations yet unborn will benefit from their labors and the long life of cast iron pipe. In recent years, both laying methods and pipe manufacturing processes have been materially improved. The service to be counted on from properly laid U. S. pit cast pipe or U. S. Super-de Lavaud *chill-free* centrifugally cast pipe is greater than ever.

U.S. cast iron PIPE

Centrifugally or pit cast—for water works, gas, sewerage, drainage and industrial service.

U. S. PIPE & FOUNDRY CO.

General Offices: Burlington, N. J.

Foundries and Sales Offices throughout the U. S.

Copyright, 1940 U. S. Pipe & Foundry Co.

● Inside this sturdy, weatherproof, cast aluminum case you'll find the same husky mechanism used in all "3C" Type "D" Heavy Duty Push Buttons. Silver-to-Silver Button Type Double Break Contacts • • • All insulating parts Bakelite • • • large electrical and mechanical clearances • • • Push Button travel not limited by contacts • • • all parts removable and replaceable with a screwdriver • • • All these are features of Type "D" Heavy Duty Push Buttons.

● And what an enclosure! Cast aluminum with evenly machined surfaces between cover and base • • • exterior operating mechanism and stuffing box mounted in the cover • • • small nut on operating shaft for adjustment of stuffing box • • • drive screws hold gasket firmly to cover • • • gasket can't buckle • • • can't come loose, can't get lost • • • gasket holes always in perfect alignment with holes in cover and base. Pilot lights with color caps for interchangeable mounting with units are available.

WRITE FOR FOLDER GIVING COMPLETE DETAILS

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

WATER WORKS & SEWERAGE, September, 1940. Volume 87. Number 9. Published monthly at 330 South Wells Street, Chicago, Ill., by the Gillette Publishing Company. Per copy, 25c. Subscription rate, United States $2.00 per year; Canada $2.40 per year; Foreign $3.00 per year. Copyright, 1940. Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under Act of March 3, 1879.

HORTONSPHERES

FOR STORING SEWAGE GAS

AN increasing number of sewage treatment plants are installing facilities for utilizing the gas produced in the digestion process. In order to do this efficiently, it is often necessary to install a gas holder to iron out the irregularities in the supply collected from the digesters.

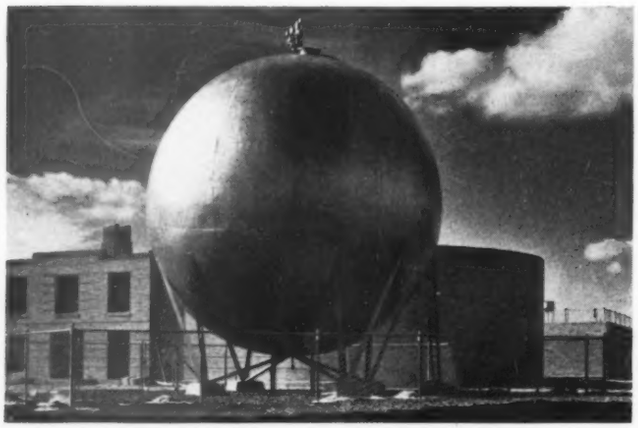
The Hortonsphere is an ideal container for this purpose. It is relatively small in size and pleasing in appearance. There are no moving parts to require maintenance or water seals to heat. The shell of the holder does not come in contact with the sewage, eliminating discoloration and the need for frequent repainting.

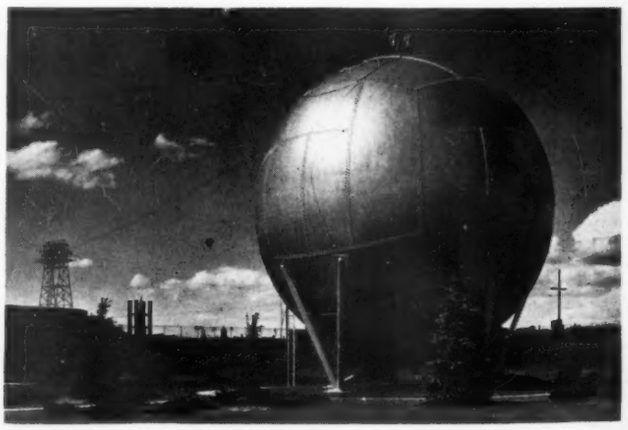
An example of this type of service is being demonstrated at Muncie, Indiana, where the Hortonsphere shown at the right is installed. This unit operates at 30 lbs. per sq. in. pressure and has a capacity of 35,000 cu. ft. of free gas. When the rate of gas production exceeds the rate of consumption, the excess gas will automatically be pumped into the holder. When consumption is greater than demand, a pressure reducing valve from the holder to the supply main will open automatically and furnish any deficiency in the production. This gas will be used primarily for driving a gas engine and for auxiliary heating.

For information on Hortonspheres for gas storage service, or other steel plate structures, address our nearest office.

BELOW, LEFT: 28 ft. 8 in. diameter Hortonsphere used to store 25,000 cu. ft. of sewage gas at the new Boulevard Sewage Disposal Plant, New Haven, Conn.

BELOW, RIGHT: 36 ft. dia. Hortonsphere of riveted construction, which stores sewage gas at 30 lbs. per sq. in. pressure for the city of Springfield, Mass.

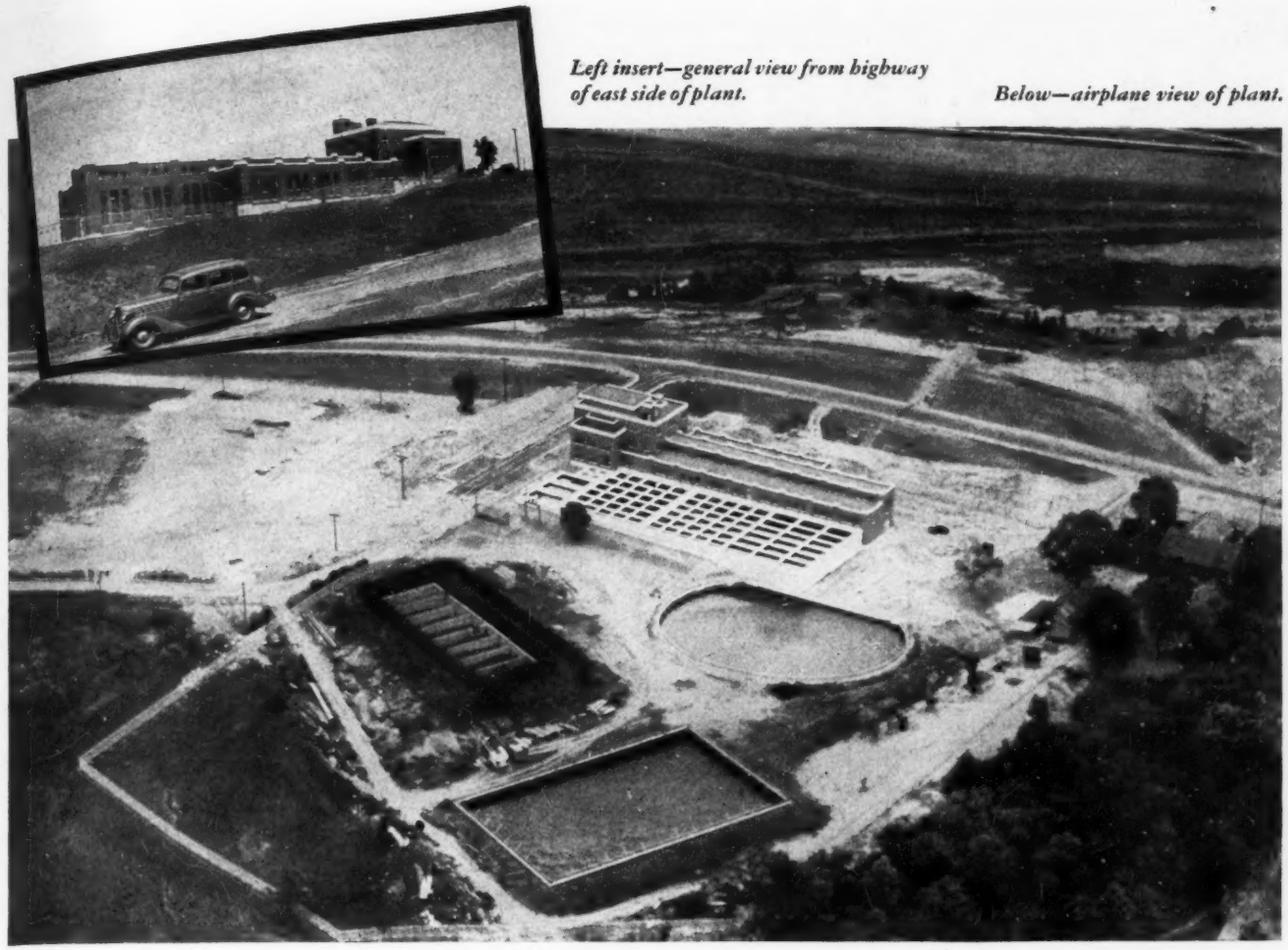




CHICAGO BRIDGE & IRON COMPANY

Chicago	2198 McCormick Bldg.	Birmingham	1586 North 50th Street	Philadelphia	1644-1700 Walnut St.
New York	3390-165 Broadway Bldg.	Tulsa	1646 Hunt Bldg.	Boston	1548 Consolidated Gas Bldg.
Cleveland	2262 Rockefeller Bldg.	Houston	918 Richmond Avenue	San Francisco	1083 Rialto Bldg.
Dallas	1679 Praetorian Bldg.	Detroit	1551 Lafayette Bldg.	Los Angeles	1455 Wm. Fox Bldg.

Plants at BIRMINGHAM, CHICAGO, and GREENVILLE, PA. *In Canada:* HORTON STEEL WORKS, LIMITED, FORT ERIE, ONT.



Left insert—general view from highway of east side of plant.

Below—airplane view of plant.

NEW HALF-MILLION DOLLAR FILTER PLANT *at Raleigh, N. C.* USES MATHIESON CHLORINE AND HTH

• With its 8,000,000 gallons daily capacity, simplified pipe gallery, centralized control and other modern features, the new Ernest B. Bain water filtering and pumping plant at Raleigh, N. C. is a model of mechanical efficiency. Behind its efficient design and operation lie the years of practical experience of such men as Ernest B. Bain for whom the plant is named. Mr. Bain began his service with the Raleigh Water Company in 1897 and has been superintendent of the water plant since 1900.

It is also experience and efficiency which dictate the use in this big modern plant of Mathieson Chlorine for water treatment in the plant and Sanitation HTH for new mains and swimming pools. Mathieson Chlorine's high reputation among sanitation engineers is built on purity, dependability, trouble-free cylinders and valves, prompt delivery service. Sanitation HTH is a dry, free-flowing chlorine carrier containing more than 70% available chlorine; a quick, handy sterilizer for special and emergency jobs.

If you have not yet received the new Mathieson wall chart "Handling Chlorine Safely," write us for your copy today.

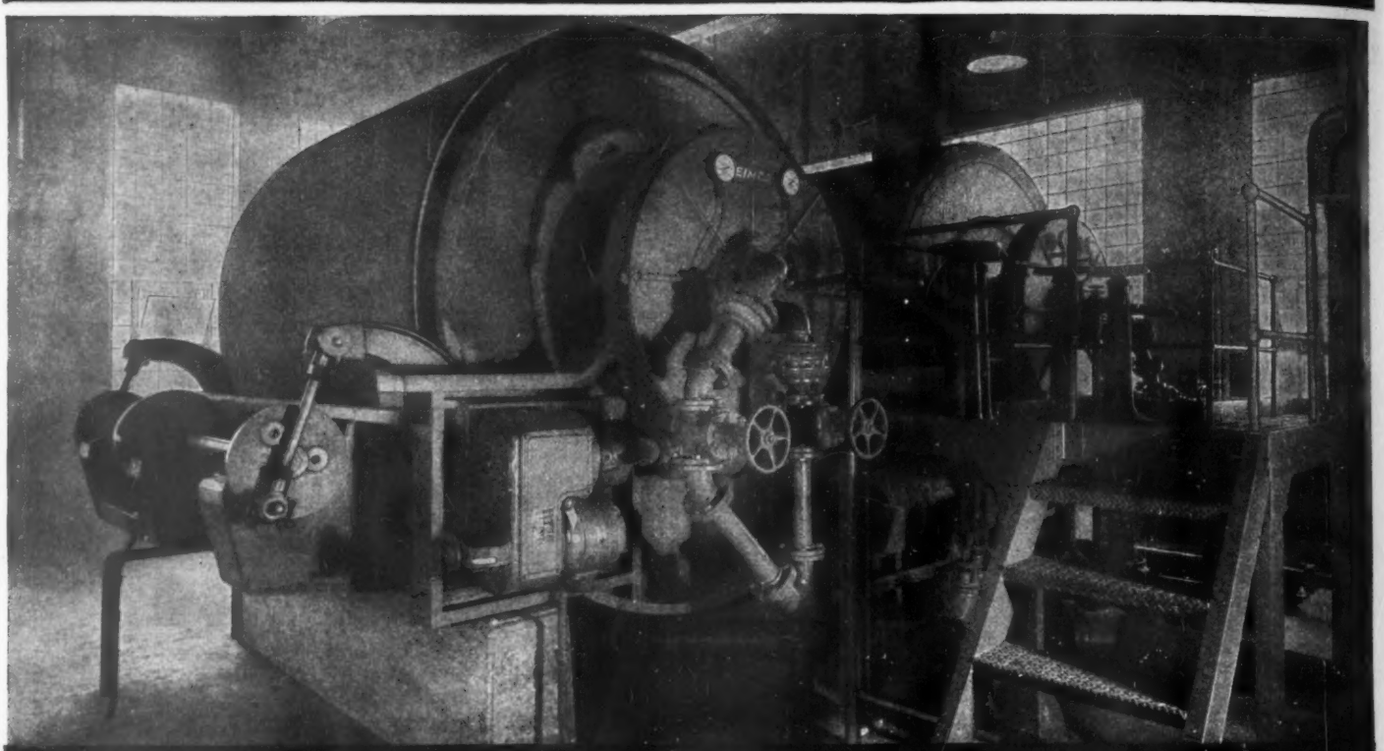
HTH comes in 5-lb. cans with replaceable caps, packed 9 cans to the case; also in 75-lb. drums.

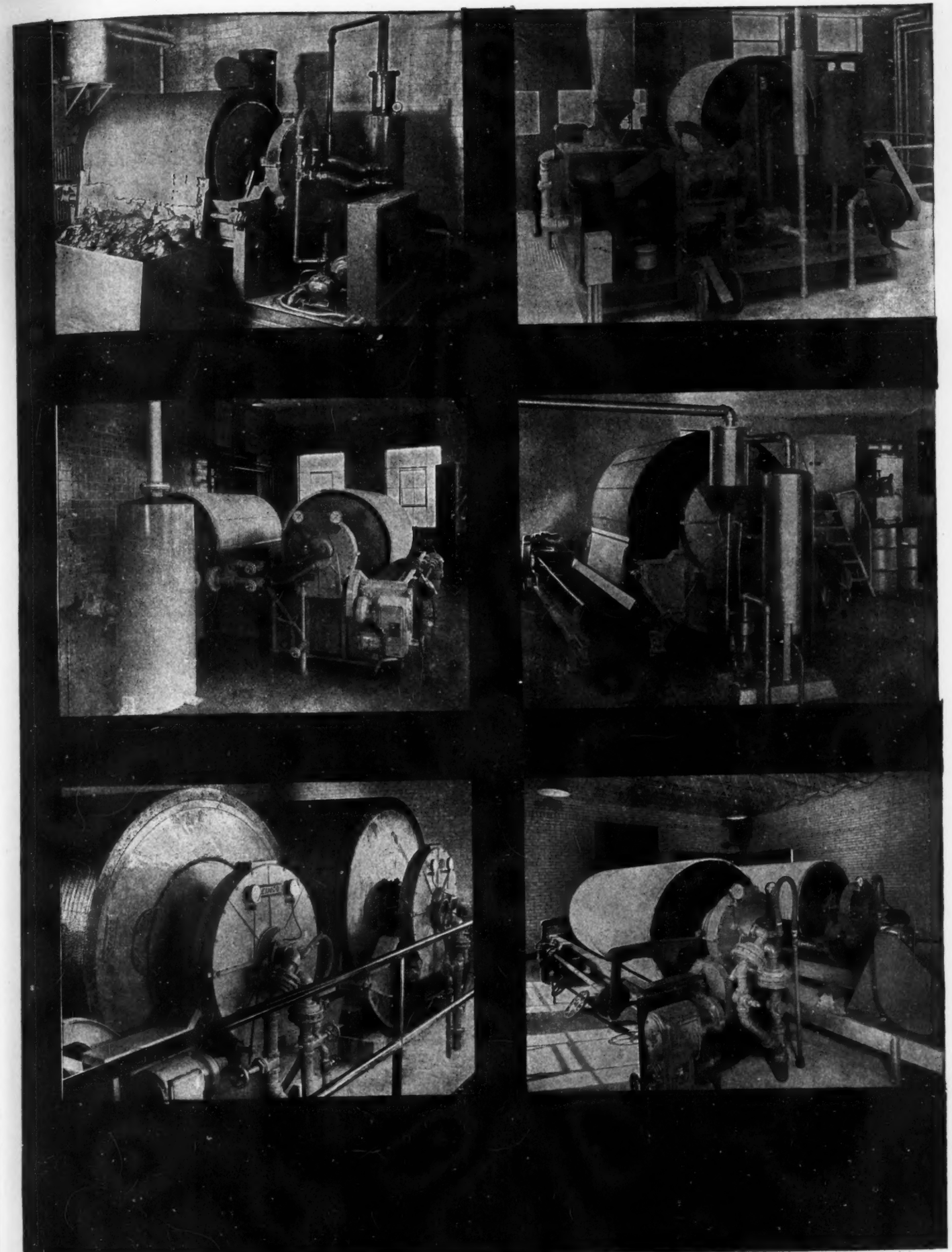
THE Mathieson Alkali Works (INC)

60 EAST 42ND STREET, NEW YORK, N. Y.

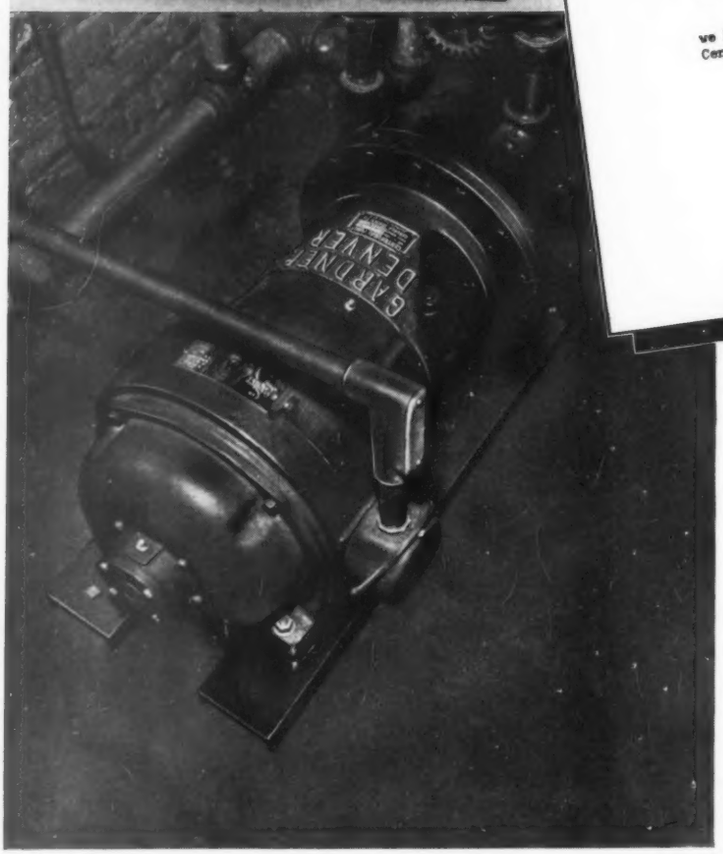
LIQUID CHLORINE . . . HTH . . . SODA ASH . . . CAUSTIC SODA . . . BLEACHING POWDER . . . BICARBONATE OF SODA . . . AMMONIA, ANHYDROUS and AQUA . . . PH-PLUS (FUSED ALKALI) . . . DRY ICE . . . CARBONIC GAS

EIMCO





...AND THAT GOES FOR THE LARGER TOWNS, TOO, MR. TYREE



W. C. BARROW, MAYOR — C. L. GRANGER, COMMISSIONER OF PUBLIC WORKS — L. A. COFIELD, TAX COLLECTOR — AMOS TYREE, MAJ. U. S. A. RET., CLERK COMMISSIONER, TAX ASSESSOR AND TREASURER

Town of DeSoto City

HIGHLANDS COUNTY

DeSoto City, Florida

May 23, 1940

To Whom It May Concern:

The records of the Town of DeSoto City, Fla., show that, for the period of six years prior to 1939, we were operating a Centrifugal pump, capacity 450 gallons per minute, using a 15 HP motor. Our monthly bills for electric power ranged from $18 per month low, to $71 per month high. We abandoned the old pump and in April 1939 installed a Type H Close Coupled Gardner-Denver Centrifugal pump, 10 HP, sold by Dave Gordon & Co. Since then our bill for power has ranged from $14.60 low to $21.30 high; most of the time running around $18 per month.

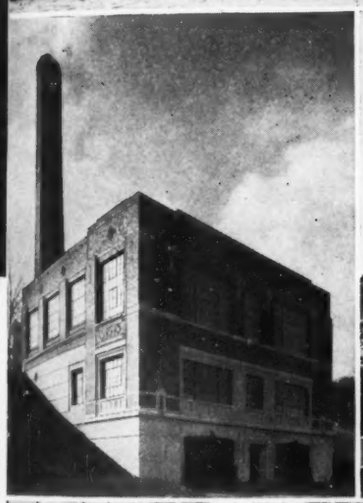
For a small town, whose finances are limited, we have no hesitancy in recommending the Gardner-Denver Centrifugal pump for economy and efficiency.

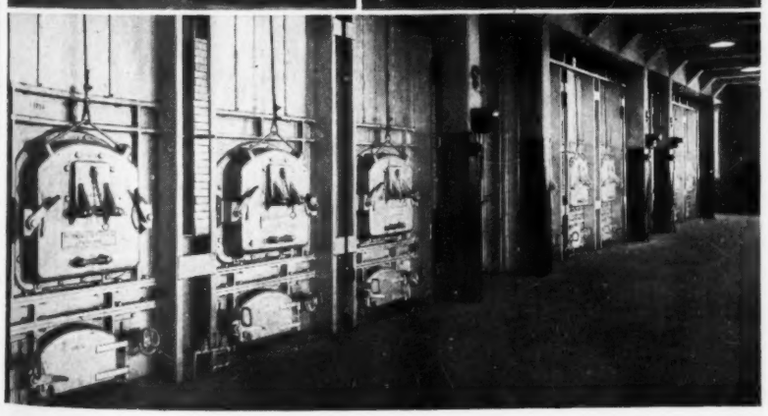
AMOS TYREE
Town Clerk & Treasurer

WASTE is waste wherever you find it. Large towns as well as small ones should take advantage of such opportunities for saving. The Gardner-Denver Type H Close Coupled Centrifugal Pump, which we have pictured above, was the answer in the case of DeSoto. It handles capacities up to 250 gallons per minute and heads up to 250 feet. Like all Gardner-Denver centrifugals, it is designed in every detail to lower the cost per gallon pumped. We will gladly consult with you on your particular problem. Don't wait—waste doesn't! Address your letter to Gardner-Denver, Quincy, Ill.

GARDNER-DENVER SINCE 1859

In MODERN MUNICIPAL INCINERATION— THE HIGHEST STANDARDS OF ECONOMY, ODOR-FREE EFFICIENCY AND FINE APPEARANCE ARE PROVIDED BY





P·DM *High-Temperature* INCINERATION PLANTS

The favorable contrast between modern P·DM Incineration and less efficient methods of refuse disposal is immediately apparent . . . to the *eye*, the *nose*, and the *civic pocketbook!*

P·DM Incineration Plants serve and ornament American communities of every size, with satisfaction that is born of finer design and construction, continued with higher performance, and confirmed by *lower costs* year in and year out.

Our latest handsomely-illustrated brochure on the subject is available on request.

PITTSBURGH · DES MOINES STEEL CO.

PITTSBURGH, PA. 3418 NEVILLE ISLAND—DES MOINES, IA. 919 TUTTLE ST.

NEW YORK, ROOM 918-99, 270 BROADWAY CHICAGO, 1222 FIRST NATIONAL BANK BUILDING

DALLAS, 1202 PRAETORIAN BUILDING SAN FRANCISCO, 625 RIALTO BUILDING

From here DOWN is where most hydrants finally wear out, freeze up, or rust apart. But not a Mathews Hydrant. Because all its underground working parts can be unscrewed and lifted out in one complete assembly for inspection, replacement, or repair. Look into it.
This is the elbow which you join permanently to the water main. Right above it is the protection case resting *loose* in the elbow. It adds strength, takes the heave of frozen ground, and forms a well through which the barrel slides to screw tight into the elbow. Note the drain holes.

It pays to specify Mathews because you'll never dig them up. Their unique design allows you to repair accidents, change nozzles, raise or lower street levels, or overhaul hydrants — all without touching a shovel. Simply lift out the barrel. Write for full description or prices.

MATHEWS HYDRANTS

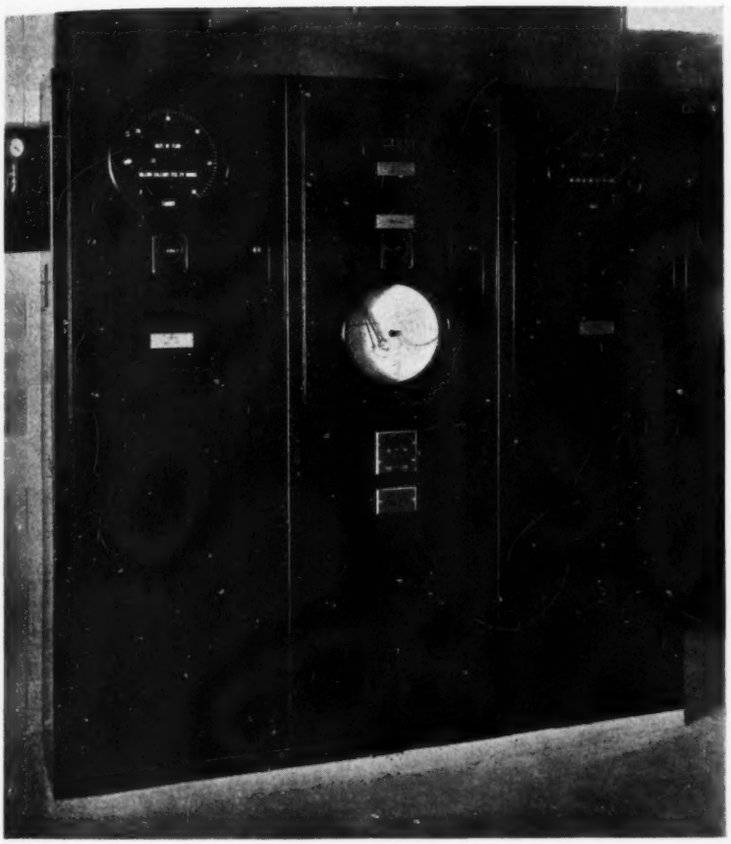
Made by R. D. WOOD COMPANY

Manufacturers of Sand Spun Pipe (centrifugally cast in sand molds) and R. D. Wood heavy-duty gate valves for water works

400 CHESTNUT STREET, PHILADELPHIA, PA.

in DALLAS

IT'S *Simplex* AGAIN



Ratio Control and Metering Panel

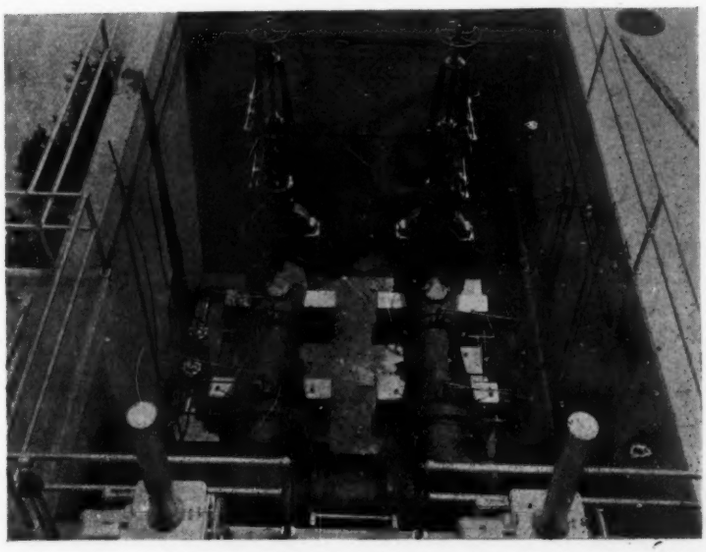
THE successful operation of the new sewage treatment works at Dallas requires the incoming raw sewage to be accurately measured, controlled and proportioned within close limits and at predetermined ratios, if the optimum efficiency and satisfactory operation of all plant functions is to be obtained.

The selection of SIMPLEX, Venturi type, "BALANCED RATIO CONTROLS" and "AIR DIFFERENTIAL" meters insures that irrespective of the operating conditions the distribution of sewage flows can be determined within the limits required.

Irrespective of whether your plant is as complete and modern as that of Dallas, or whether your problem involves the simple metering of flows or the balancing and control of sewage, sludge or air, there is a SIMPLEX instrument that will solve your problem. Competent engineers will be glad to discuss your requirements with you at your request.

WRITE FOR DATA

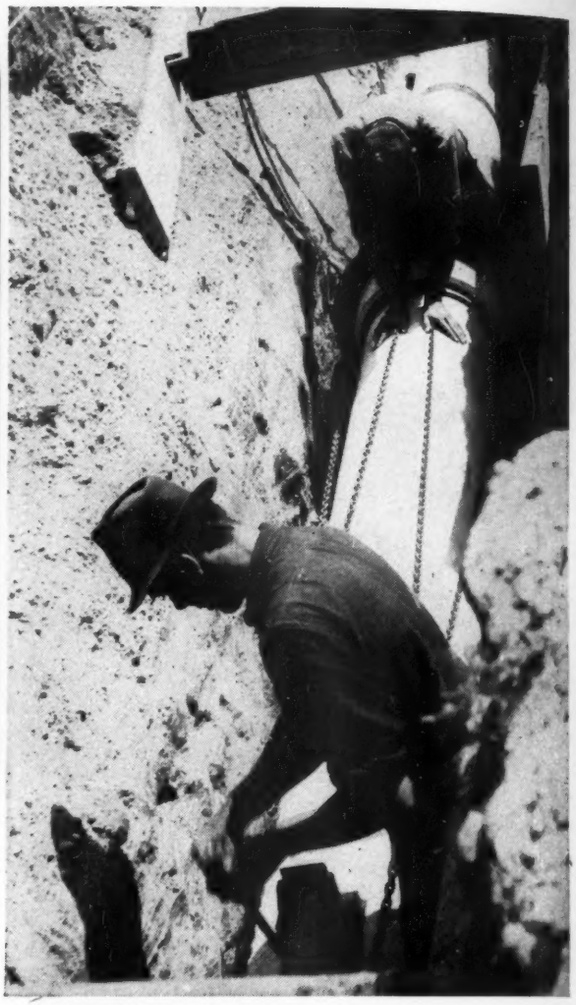
Metering Pit—Showing 36" Venturi Tubes with Control Valves installed in head recovery cone.



SIMPLEX
VALVE & METER
COMPANY

6743 UPLAND STREET
PHILADELPHIA, PA.

...ONE PROVED WAY TO CUT YOUR WATER-LINE COSTS...



CHICOPEE FALLS, MASS.—More than 11,000 ft. of 16" Transite are providing efficient, low-cost service for this airfield. Wherever used, Transite's light weight and simple assembly speed up work, cut handling costs.

Hundreds of American communities are enjoying more efficient, economical water transportation with J-M Transite Pipe. Check the many ways this modern material can cut costs for you . . .

NO MATTER how large or how small your community, there are definite water-line savings possible with J-M Transite Pipe. Under conditions just like yours, engineers find that this durable water carrier reduces upkeep and operating expense . . . brings installed cost down to rock bottom.

Unusual Corrosion-Resistance

Made of asbestos and cement, Transite offers high resistance to corrosive ground water, acid and alkaline soils. Being non-metallic, it is immune to electrolysis. Lastingly durable and uniform in strength, it maintains its resistance to traffic stress and earth loads in service.

Tuberculation Impossible

Because Transite is non-metallic, its high flow coefficient (C=140) can never be reduced by tuberculation. As a result, it is frequently possible to use smaller, less expensive sizes of pipe . . . for there's no need to allow for decreases in capacity due to tuberculation.

When Do Savings Start?

You begin to save with Transite right at the railhead. Its long lengths are light in weight . . . easy to handle and transport. Simplex Couplings make assembly fast, easy and economical . . . eliminate the need for large bell holes at joints. And they form tight joints that *stay tight in service* . . . minimize costly water loss.

For full details, write for brochure TR-11A. And for facts on lower cost sewage disposal, send for Transite Sewer Pipe brochure TR-21A. Write Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS-MANVILLE PRODUCTS JM

JOHNS-MANVILLE

DALLAS, TEXAS—Simplex Couplings eliminate large bell holes. Trenches are held to narrowest possible widths . . . trenching expense is minimized.

LOS ANGELES, CALIF.—Being non-metallic, Transite cannot rust or tuberculate. And its high flow coefficient (C=140) helps keep pressures high, pumping costs low.

MANCHESTER, MICH.—Transite's asbestos-cement composition provides unusual durability and virtual freedom from maintenance through the years.

MOUNTAIN VIEW, N. J.—Transite's uniform strength and durability effectively resist soil stress and traffic pressure. Its speedy assembly cuts the time trenches must be open.

ALBION, WIS.—With Simplex Couplings, joints are made in a fraction of the time required by ordinary methods. They are assembled cold, without heating equipment, just as they are received from the factory.

ORRVILLE, OHIO—Low installation costs . . . reduced pumping expense . . . negligible maintenance . . . all add up to a substantial three-way saving in water-transportation costs when Johns-Manville Transite Pressure Pipe is used.

TRANSITE PIPE

THE MODERN MATERIAL FOR WATER AND SEWER LINES

FORGET CLAIMS —GET THE FACTS!

on Activated Carbons

With these 3 methods you can check PERFORMANCE for yourself!

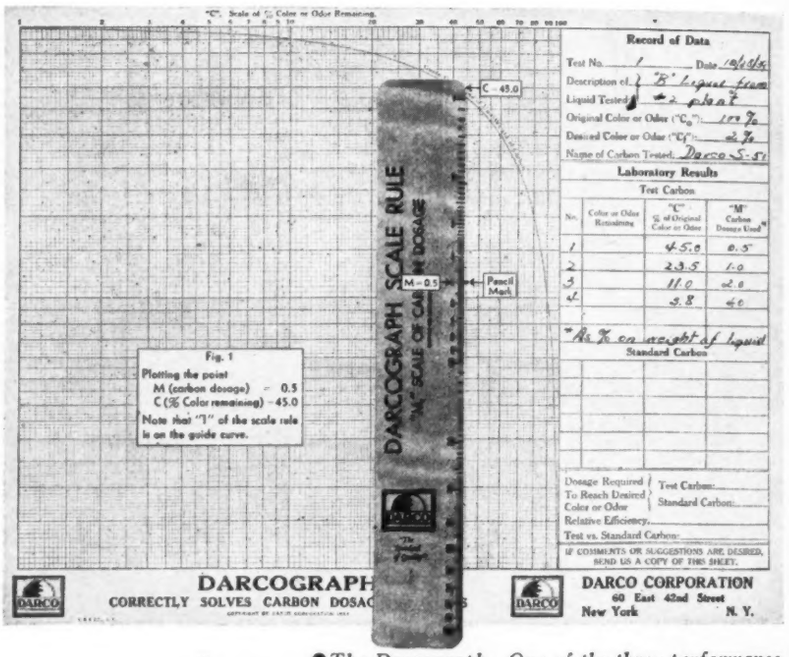
You don't have to count on "claims" in buying activated carbon today. You don't have to be "in the dark"—when the Threshold Odor Test, the Carbon Feed Chart, and the Darcograph throw ample light on carbon performance!

Use these impartial, scientific methods to select the best carbon for the water you have to treat.

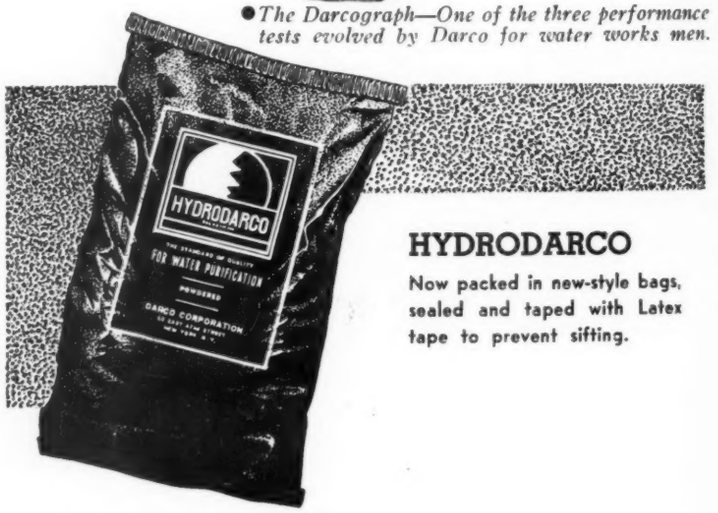
Use these methods, also, to check uniformity in every shipment, and to evaluate the effectiveness of different methods of application.

And for best results in removing tastes and odors, use HYDRODARCO—the activated carbon specially made for water treatment. Compare HYDRODARCO with any other carbon. Prove for yourself that it offers maximum palatability control per dollar!

Write for a sample and full details.



●The Darcograph—One of the three performance tests evolved by Darco for water works men.



HYDRODARCO

Now packed in new-style bags, sealed and taped with Latex tape to prevent sifting.

Hydrodarco Reg. U. S. Pat. Off.

DARCO

DARCO CORPORATION

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You Can Write the Order

THAT WILL END SEWER TROUBLES!

OFFICE OF PUBLIC WORKS

Jim —

Let's reline that old sewer with Asbestos-Bonded Armco Sewer Pipe. Then we can stop this continual maintenance expense and have a permanent job at less than half the cost of building a new sewer.

Mac

Here's a way to solve those difficult sewer problems once and for all. Specify Asbestos-Bonded ARMCO Sewer Pipe for economical repair work or new construction.

Asbestos-Bonded ARMCO Pipe meets every sewer line requirement. Its flexible corrugated design eliminates breakage and strong, tight joints greatly reduce the danger of infiltration. Long lengths mean fewer joints per mile and lower installation costs. Cradling is unnecessary.

Also important, ARMCO Sewer Pipe brings assurance of material durability. The galvanized ARMCO Ingot Iron is proved by a 33-year service record in sewers. Now a thick pavement in the bottom and full bituminous coating inseparably bonded to the pipe offer much longer service.

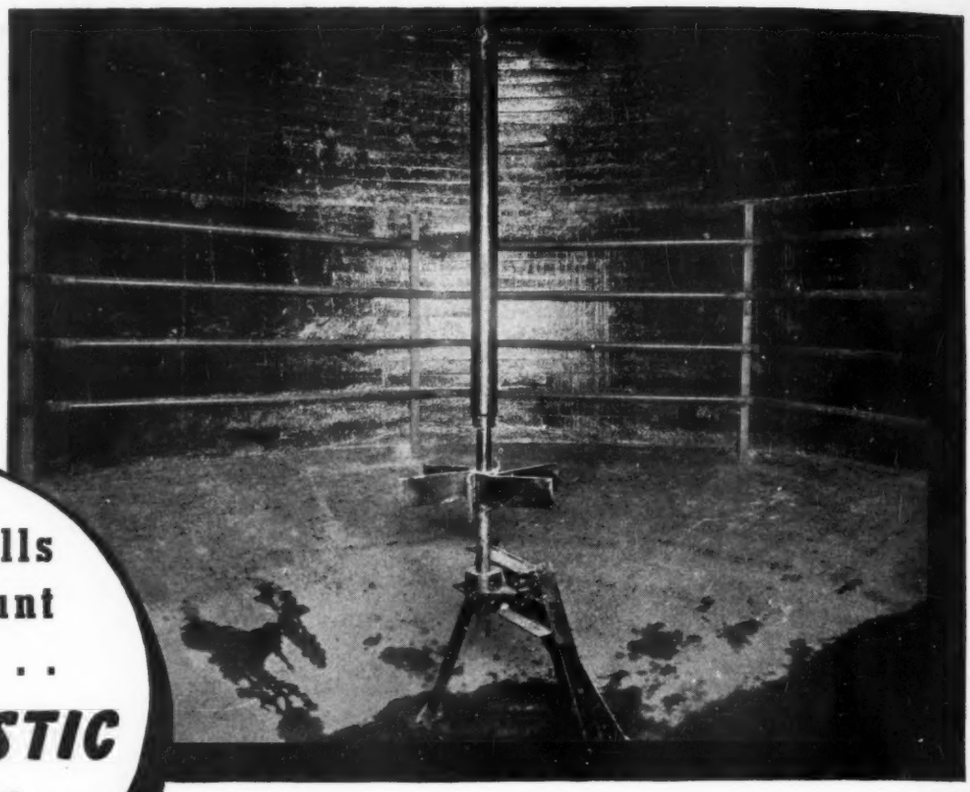
Many major cities have benefited by installing Asbestos-Bonded ARMCO Sewer Pipe. Yours can too. A request to us will bring you complete information with no obligation. Armco Drainage Products Association, 5010 Curtis St., Middletown, Ohio.

A disintegrating brick sewer is permanently repaired with Asbestos-Bonded ARMCO Sewer Pipe. Approximately 600 feet of 72-inch ARMCO Pipe was threaded into the sewer without interrupting street traffic and at less than half the cost of rebuilding.

ASBESTOS-BONDED ARMCO SEWER PIPE

ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

The List of Users GROWS . . .



Bitumastic No. 50 protecting interior of sludge digestion tank, of new Hudson Fall sewage treatment plant. Designing and Supervising Engineers: Whitman, Requardt and Smith, Albany, New York

Hudson Falls Sewage Plant specifies . . .

BITUMASTIC No. 50

Today, the area within and adjacent to Hudson Falls, New York, is being served by a new, modern sewage system—including Sanitary and Storm Water Sewers, Sewage Interceptors along the Hudson River, a Sewage Pumping Station, and a new Sewage Treatment Plant.

Erected at a cost of $225,000 and embodying the most recent advances in design and equipment, the new Hudson Falls Sewage system is another example of the role played by Bitumastic No. 50 in the plans of Water Works and Sewage Engineers. For this coating now protects against deterioration portions of the walls of pumping station substructure, the sludge control building, clarifier tank, Venturi flume, grit chambers and sludge digestion tanks of the new plant.

Engineers have come to rely on Bitumastic No. 50 as an effective ally in combating the deadly moisture and fumes around sewage plants. Developed from a background of over 80 years in solving the severest corrosion problems, Bitumastic No. 50 can withstand extreme variations in atmospheric temperatures without cracking or sagging. It is a coal tar base product, *applied cold* up to a thickness of 1/16 of an inch, is not an emulsion and contains no asphalt. It is a heavy-bodied plastic material, which, upon stirring, becomes sufficiently liquid to brush out easily and may even be sprayed.

If you are confronted with a serious corrosion problem, you are urged to write today for a free file-size Guide containing recommendations for Bitumastic No. 50 and other Bitumastic products for specific parts of sewage plants and structures. Ask for Form 838.

●

Also manufacturers of a complete line of Industrial Maintenance Paints

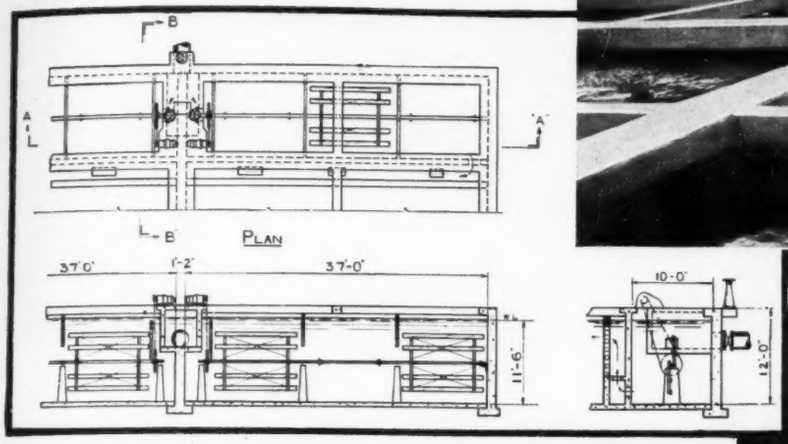
WAILES DOVE - HERMISTON CORPORATION

WESTFIELD, NEW JERSEY

NEW YORK · PHILADELPHIA · CLEVELAND · CHICAGO · HOUSTON · TULSA · SAN FRANCISCO · LOS ANGELES · MIAMI

Filtration plant at Fredericksburg, Va., with mixing tanks on the far side, settling tanks in the foreground.

Working drawing showing special arrangement of Link-Belt mixers at Fredericksburg filtration plant



CHEMICAL COSTS *Slashed* with LINK-BELT HORIZONTAL MIXERS

A material saving in chemicals with a 100 percent increase in capacity has been brought about by extensive remodelling at the Fredericksburg, Va., filtration plant. The "around-the-end" type of mixing tank was abandoned in favor of tanks equipped with Link-Belt horizontal mixers. The addition of filters and settling tanks has increased the capacity of the plant from 2 million gallons to 4 million gallons per day. The settling tanks and filters operate at the same rate as previously, yet the chemical dosage has been cut 35% for alum and 50% for lime. This is made possible through the increased efficiency of the flocculation tanks.

The Link-Belt flocculation equipment in each tank consists of a horizontal shaft divided into three sections, each section having four redwood paddles with an outside diameter of 7'0".

LINK-BELT WATER and SEWAGE TREATMENT PLANT EQUIPMENT INCLUDES: STRAIGHTLINE Collectors, CIRCULINE Collectors, STRAIGHTLINE Mechanically Cleaned Bar Screens, Tritor Screens, STRAIGHTLINE Grit Collectors and Washers, Elevated Diffusers, STRAIGHTLINE and CIRCULINE Sludge Collectors for Primary and Secondary Tanks, STRAIGHTLINE Scum Breakers for Digestion Tanks, Reciprocating Distributors, Travelling Water-Intake Screens, and a complete line of elevating, conveying and power transmitting equipment.

LINK-BELT COMPANY

Specialists in the Manufacture of Equipment for Water and Sewage Treatment Plants

PHILADELPHIA 2045 W. Hunting Park Ave. — CHICAGO 300 W. Pershing Road — LOS ANGELES 361 S. Anderson St. — CLEVELAND 548 Rockefeller Bldg.

Atlanta . . Baltimore . . Boston . . Buffalo . . Dallas . . Denver . . Detroit . . Grand Rapids . . Houston . . Huntington, W. Va. . . Indianapolis . . Kansas City, Mo. Louisville . . New Orleans . . New York . . Oakland, Calif. . . Pittsburgh . . Portland, Ore. . . Salt Lake City . . Seattle . . St. Louis . . St. Paul . . Wilkes-Barre

In Canada—Link-Belt Limited—Toronto Plant; Montreal; Vancouver; Swastika

8269

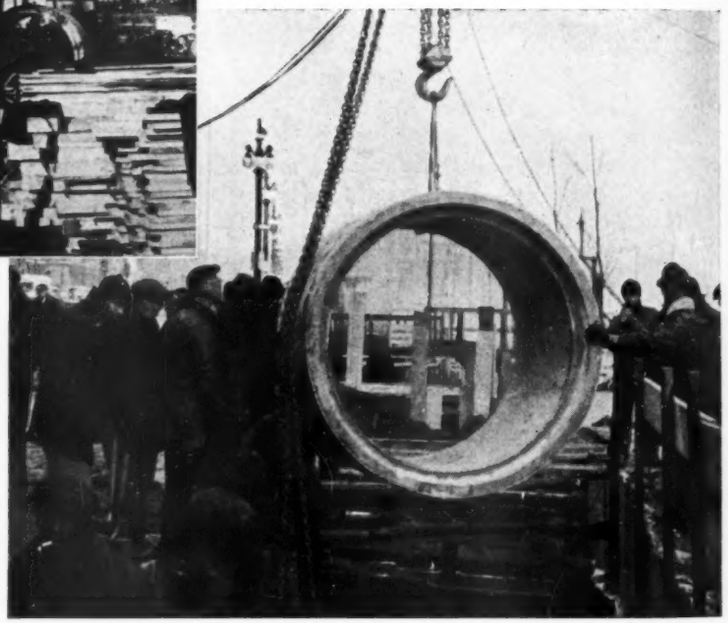
LINK-BELT

SCREENS · COLLECTORS · AERATORS · GRIT CHAMBERS · MIXERS

See our EXHIBIT at the Federation of Sewage Works Associations Convention, Palmer House, Chicago, Oct. 3-4-5.

In 4½ years, Chicago's sewerage program added 109 miles of CONCRETE PIPE

Constructing a 66-in. reinforced concrete pipe sewer in Michigan Ave., Chicago, Ill., in Feb., 1939. This is part of a 1900-ft. section ranging in diameter from 60-in. to 84-in.



Extension and reconstruction of Chicago's combined sewerage system from November, 1935, to April, 1940, entailed the use of 575,756 feet—109 miles—of concrete sewer pipe and reinforced concrete sewer pipe. Diameters ranged from 6 to 102 inches. The program included 71 miles of pipe in sizes 24 inches or smaller, 30.8 miles being 12-inch.

Chicago is one of scores of cities large and small in which concrete recently has been specified for major sewerage programs. Concrete sewers, when properly designed and built, minimize infiltration and leakage, have maximum structural strength and last indefinitely, as shown by numerous examples found in excellent condition after half a century or longer.

Two important steps will insure the success of any sewerage program: place the work in the hands of a competent sanitary engineer, and specify concrete pipe and reinforced concrete for sewers of all sizes.

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A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

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of interest to everyone in the field of Sanitary Engineering

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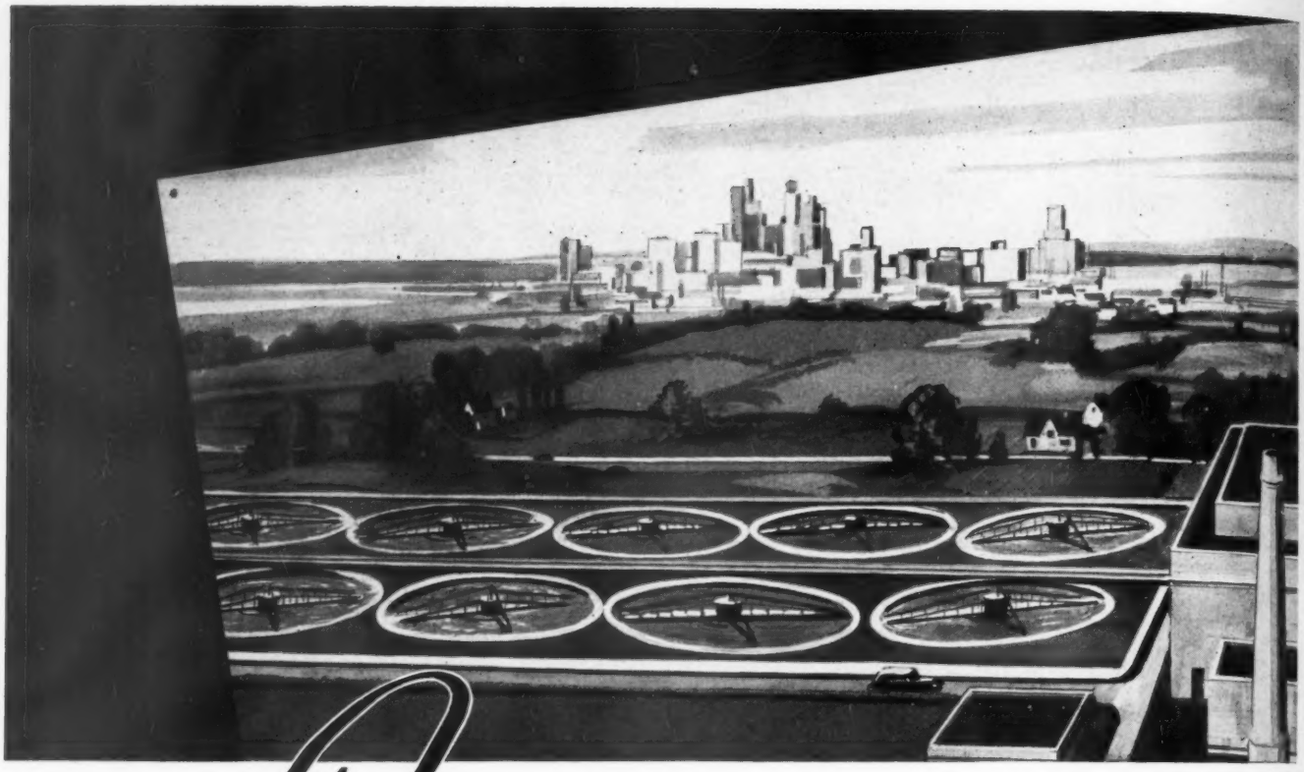

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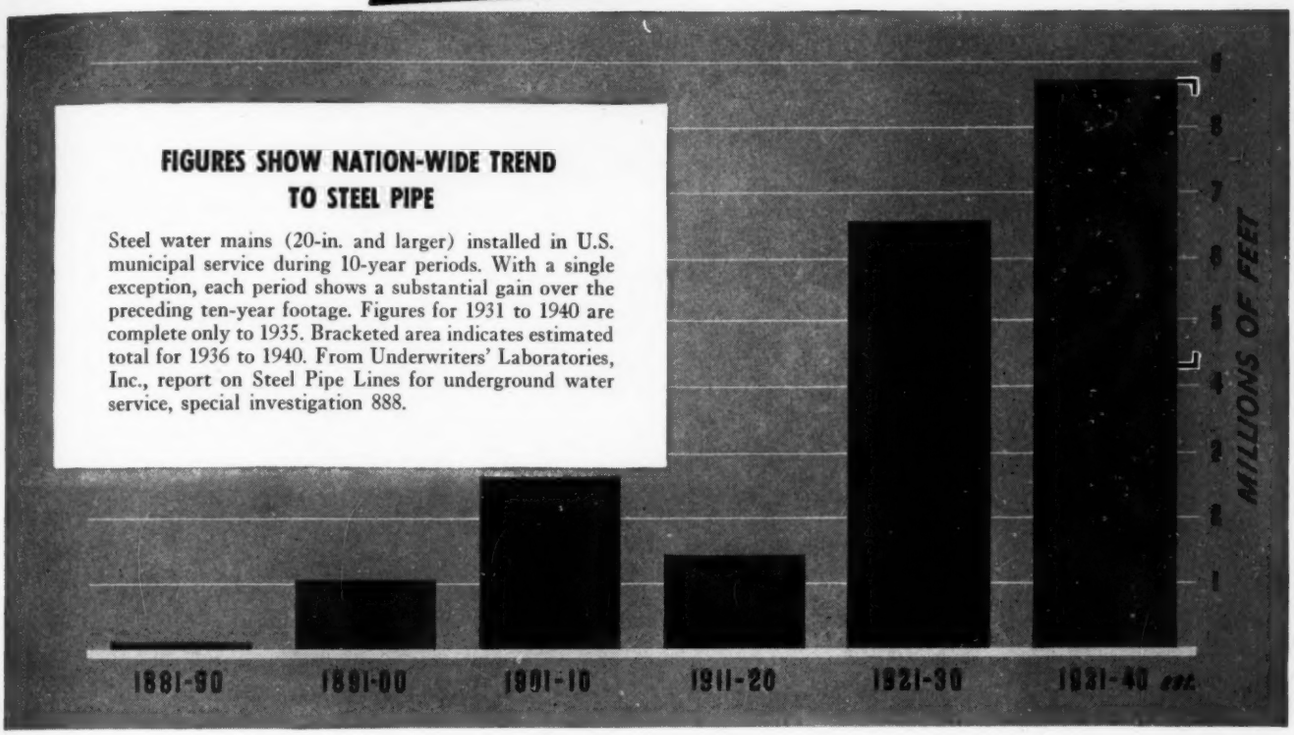
234 Prominent Cities using *Steel* Water Mains


FIGURES SHOW NATION-WIDE TREND TO STEEL PIPE
Steel water mains (20-in. and larger) installed in U.S. municipal service during 10-year periods. With a single exception, each period shows a substantial gain over the preceding ten-year footage. Figures for 1931 to 1940 are complete only to 1935. Bracketed area indicates estimated total for 1936 to 1940. From Underwriters' Laboratories, Inc., report on Steel Pipe Lines for underground water service, special investigation 888.
MILLIONS OF FEET
1881-90
1891-00
1901-10
1911-20
1921-30
1931-40 est.

FROM Maine to California, from the Lakes to the Gulf, American cities are turning to steel pipe as the safe, economical material for water mains. Listed in a recent report of the Underwriters' Laboratories, Inc., are 234 cities in the United States which are using this pipe. And this report includes only mains 20-in. and larger, installed *before* 1936—a total of over 16,200,000 feet of steel pipe!

Here is proof that municipal water engineers are recognizing, more and more, the advantages of steel pipe—its high strength which prevents sudden, costly failures—its light weight and easy-laying qualities—its ability to serve dependably for long periods of years.

National Tube Company, always a leading factor in the development and manufacture of steel pipe for water mains, stands ready to serve you in the planning and laying of adequate water service facilities. For assurance of long-term satisfaction, specify NATIONAL Steel Pipe. Write today for complete engineering data.

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3. LIGHT WEIGHT. Saves freight and trucking charges. Speeds laying.

4. SHATTERPROOF. Eliminates sudden ruptures, as in case of fire or other emergencies. Reduces property damage.

5. SMOOTH SURFACE. Ideal for dips or coatings, where necessary. Greater carrying capacity.

6. LONG SERVICE. Sixty-year old installations still in service.

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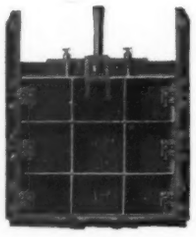
To the Water Supply and Sewage Disposal industries, Crane offers complete assistance in applying Preventive Maintenance successfully. With a line of over 38,000 items representing the finest development in flow-control equipment; with unmatched laboratory and plant facilities; and with a vast experience in solving piping problems, Crane can supply the right valve for every service need. And that's where dependability and lasting performance begin.

Can you afford to pass up the advantages of Preventive Maintenance when it costs no more than ordinary maintenance? Talk it over with your Crane Representative.

We'll be looking for you at the Crane Exhibit New England Water Works Association Convention, Hotel Commodore, New York—September 23 to 27.



(*Left*) LONGER LIFE IN FILTER WASH LINES—An official test of 5,000 operations showed no sign of any objectionable wear in this new 36″ Crane wash line valve. One of many improvements is the simple disc retracting device. It saves wear by eliminating dragging of discs across seats.

(*Right*) YOU'LL HAVE PEACE OF MIND—and positive control of your system by equipping with Crane No. 480½ A. W. W. A. gate valves. Comply with latest specifications in effect May 1, 1939.

(*Left*) NO RIVETS OR SCREWS TO CAUSE SCORING—in Crane Sluice Gates. The Crane seat mounting method avoids this danger. Made in all sizes and types for seating or unseating pressures.

(*Right*) FOR SAFER CHLORINATION SERVICE—Trimmed with Monel, this specially designed Crane plug type disc valve assures dependable control of chlorine gas lines.

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Solves Four Major Water Problems

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2. Prevents precipitation of dissolved iron
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4. Prevents scale formation from high-bicarbonate waters

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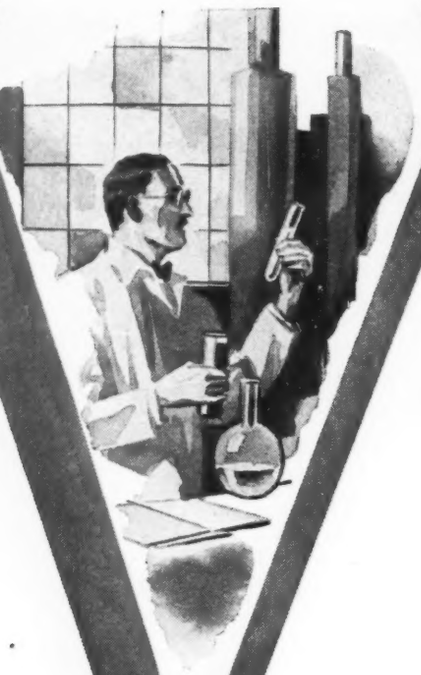
VALUE



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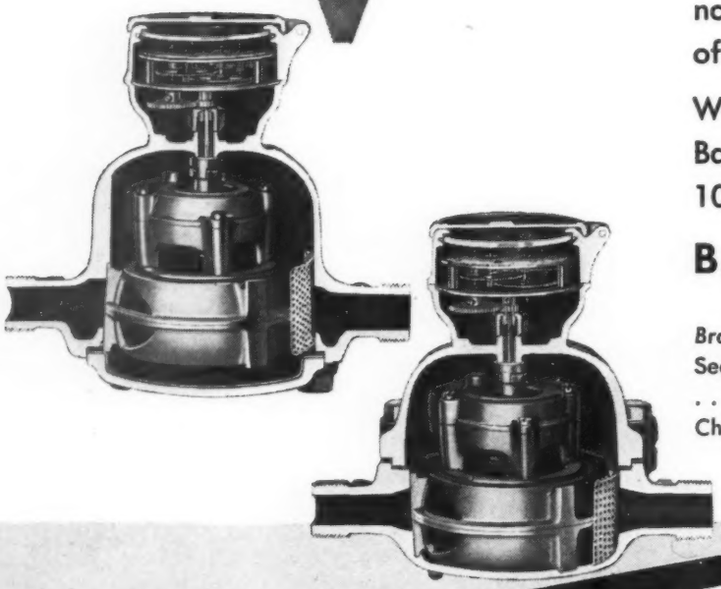

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BADGER Water METERS

SPECIFY PERFECTED AND PROVEN CONTROL FOR SECONDARY TREATMENT

Simple and effective process control based on proven factors is necessary to produce a consistently high degree of purification under varying conditions.

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4. Tapered Aeration control with mechanical Aerators and Swing Diffuser System.

Fig. 2353—"Chicago" Aeration System with Stationary Diffuser Tubes at the Gary, Ind., Activated Sludge Plant.

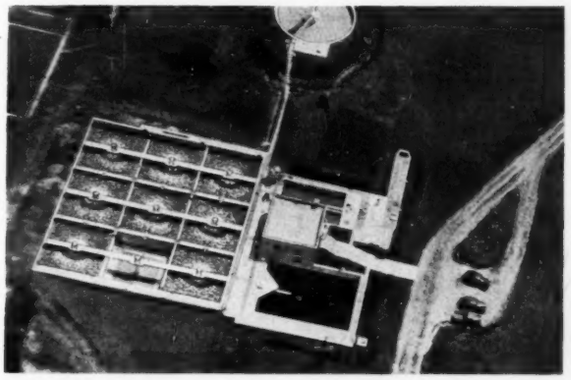

Fig. 2354—Airplane view of Belvidere, Ill., Sewage Treatment Plant with "Chicago" Mechanical Aerators.

TEN YEARS EXPERIENCE IN ACTIVATED SLUDGE CONTROL

Based on initial operation supervision, plant regulation and training operators in more than one hundred successful Activated Sludge Plants treating normal and strong domestic and mixed sewages, including industrial wastes from dairies, textile mills, canneries, meat packing plants and institutions.

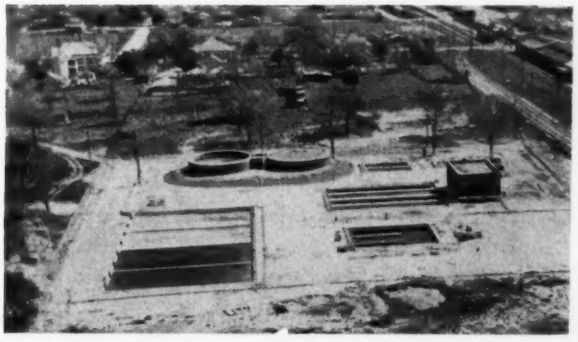

Fig. 2356—Airplane view of Activated Sludge Plant at Lake Charles, La., equipped with "Chicago" Swing Diffusers.

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The chlorine control equipment in your plant contains small passages that chlorine impurities can easily obstruct. Pennsylvania Salt Manufacturing Co. resolved to eliminate such impurities as far as humanly possible . . . and succeeded to a marked degree.

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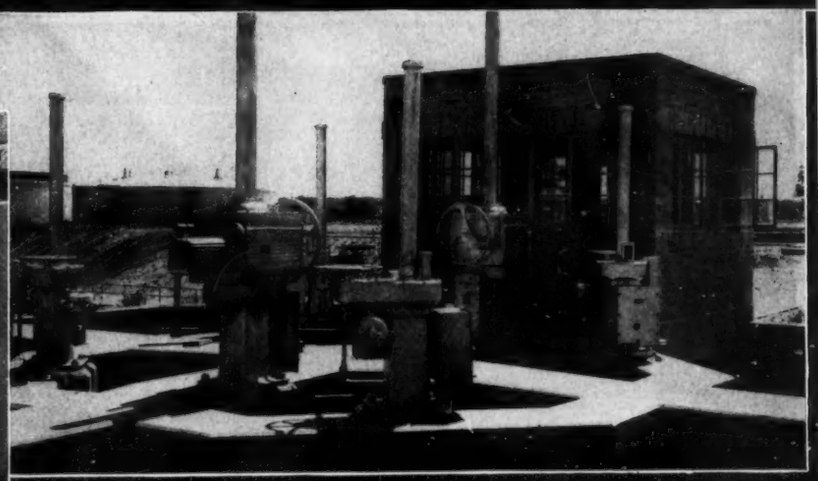

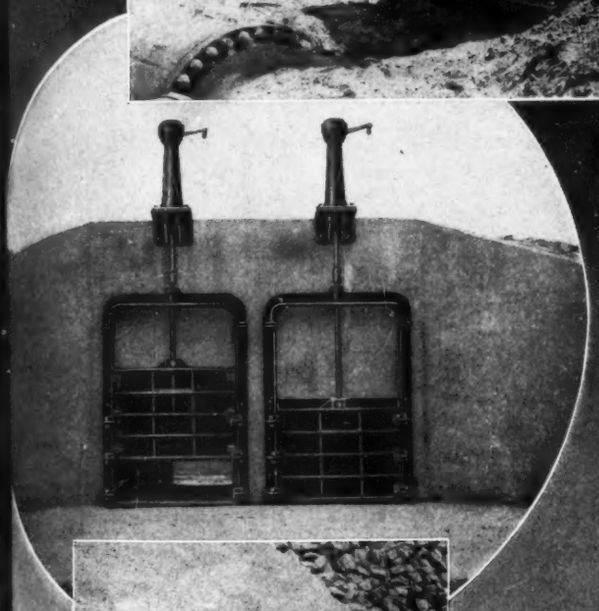

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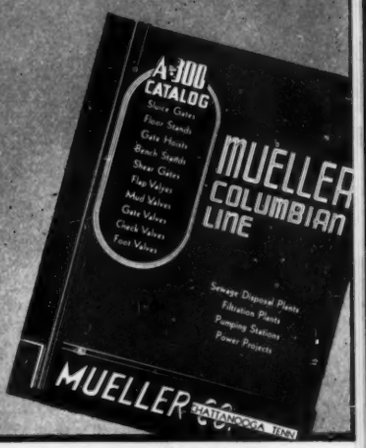

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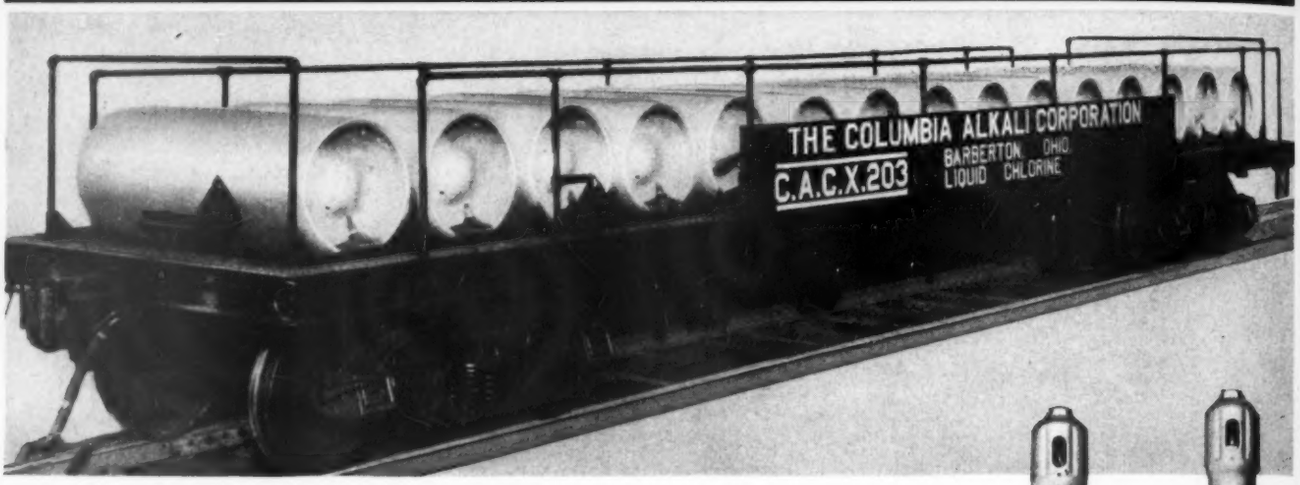

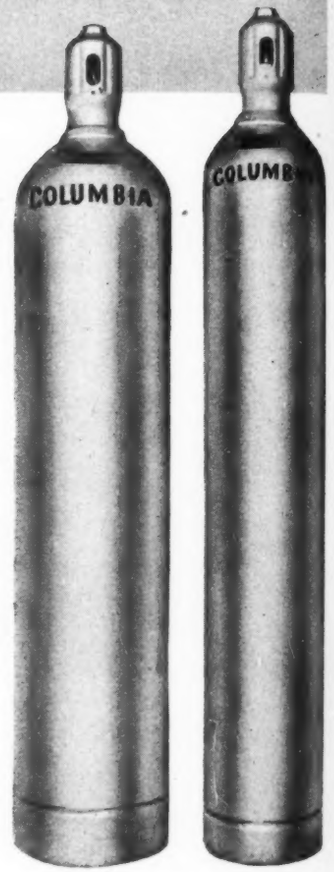

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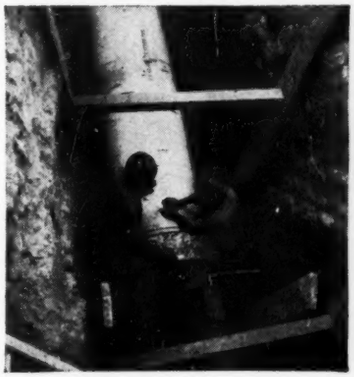
FOR GREATER SAVINGS ON YOUR SEWER LINES—

Shown on this page are a few typical installations of J-M Transite Sewer Pipe—representative examples of the many American municipalities enjoying more efficient and economical sewage disposal with this modern, durable material.

Glen Cove, N.Y. With a shallow cover, ranging from a maximum of 42 in. down to as low as 20 in., the pipe on this job had to be able to withstand heavy industrial trucking. Furthermore, it was installed in corrosive filled ground. Transite was selected because of its uniformly high strength and unusual resistance to corrosion.

Pearl River, N.Y. Trenches up to 26 feet deep . . . yet J-M Transite Pipe, Class two, was installed *without a cradle!* Transite withstands heavy earth loads like this, because of its unusual toughness and the fact that it combines great durability with uniform strength. Here, at Pearl River, Transite's long 13-ft. lengths, light weight and ease of handling resulted in exceptionally rapid installation and low handling costs.



Danbury, Conn. Because of its smooth interior surface, Transite Sewer Pipe provides a flow coefficient as low as n=.010. Its resultant high carrying capacity made it possible to use smaller diameter pipe on this job at Danbury.

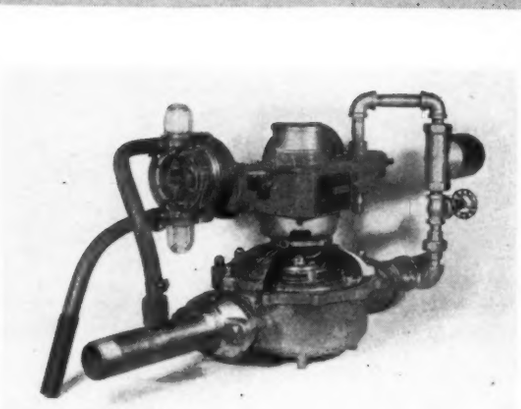
North Tarrytown, N. Y. On this installation, the economies that are possible due to Transite's high carrying capacity were taken advantage of in the form of flatter grades with shallower trenches and lower trenching costs.

Iowa City, Iowa. Transite Sewer Pipe helps you keep sewage-treatment costs at a minimum. For Transite lines have fewer joints (because of the long 13-ft. lengths), and what joints there are stay unusually tight in service. Therefore, infiltration is greatly reduced, sewage load is smaller and operations at the treatment plant are more efficient, less expensive.

FULL DETAILS will show you how J-M Transite Sewer Pipe helps provide better sewage disposal at lower cost. Send for brochure TR-21A. And if you're interested in improving water service, write for J-M Transite Water Pipe brochure TR-11A. Address Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville TRANSITE PIPE **The Modern Material for Sewer and Water Lines**

News from % Chemical Feeder Headquarters



(Patent Pending on "See Thru" Construction)

(Above) Meter Controlled Chlor-O-Feeder with "See Thru" Reagent Parts

(Left) "See Thru" Diaphragm Box

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"The New Filtration Plant of Raleigh"
Will be described in a featured article which will emphasize novel elements in the design and equippage of the recently completed filter plant of Raleigh, North Carolina. This plant is reputed as being the finest in the South and complete to a detail. The author, and designer—
WM. C. OLSEN, Consulting Engineer
Raleigh, North Carolina

"The Rehabitation of Transmission and Force Mains"
Is an article which describes the cleaning and lining in place of 34,000 feet of important supply and transmission mains at Akron, Ohio. It discusses the considerations involved in the decision to line with cement mortar by the "Centriline" centripetal process of application as the most practical and economical means of returning these mains to their original capacity or better. A description of the procedure and equipment utilized, experiences encountered, and results attained are set forth in his usual lucid style by—
WENDELL R. LA DUE, Sup't. and Engineer
Bureau of Water Supply, Akron, Ohio

"Biofiltration in Sewage Treatment—Experiences to Date"
Is a review of performance records of high rate (high capacity) trickling filters in service, and a discussion of applications of this newer method of purification for a great variety of duties. Especial attention is given the ability of this method to take shock loads seasonally and its worthiness in industrial waste treatment. The author—
DR. A. J. FISCHER, Development Engineer
The Dorr Company, New York, N. Y.

"A 1940 Model Sewer Service and Maintenance Truck"
Has been specially designed by the maintenance staff of the Sewerage Commission of Essex and Union Counties, New Jersey, known as the "Joint Meeting." Readers will recall a splendid earlier article in our September 1939 issue (reprinted also in the Reference and Data Section of our April 1940 issue) describing sewer maintenance practice and equipment of the Joint Meeting. Herein was described a radio-equipped and otherwise complete Sewer Service Truck. Based on experience with two earlier trucks, the Joint Meeting designed its new (1940 model) truck which is now in operation. With every possible detail incorporated this "last word" in sewer service trucks is to be described and pictured by—
E. P. DECHER, Ass't. Sec'y. and Purchasing Agent
The Joint Meeting, Newark, N. J.

"America's Softening Plants of Special Interest"
Are to be the subject of a series of articles which are being prepared by the author from his notes covering items of particular interest observed or learned when visiting the more important water softening plants in the United States. The author in his coast to coast "round-up" of water treatment plants was able to collect data from which his timely and interesting articles, highlighting design and operating experiences at such plants, has been developed. His observations were made as an operator seeking the best that has been produced in plant design and treatment practices, in consequence being of special interest to designers, operators and those considering or contemplating softening in the near future. The author—
L. J. ALEXANDER, Engineer of Operation
Southern California Water Co., Los Angeles

"Operating Fundamentals of the Activated Sludge Process"
Those who have read earlier contributions of the author will need no encouragement to watch for his forthcoming article on the above topic. A former designer and an experienced operator since, as well as a keen observer, the article to appear will prove a valuable guide to activated sludge plant operators—and, too, to designers. It is, however, written for operators by an operator to aid in attaining dependable and economical plant performance. The author—
T. R. HASELTINE, Sup't. of Sewage Treatment
Butler and Grove City, Penna.

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WATER WORKS & SEWERAGE

VOL. 87, NO. 9 *A Gillette Publication* SEPTEMBER, 1940

WATER SOFTENING AT ANN ARBOR

Has Solved the Half-Century Water Problem of This City

By H. H. CASWELL, Manager
Water Department
ANN ARBOR, MICHIGAN

The Author

THERE is only one Ann Arbor, the home of the University of Michigan. This fair city is situated in the valley of the Huron about forty miles west of Detroit. The local population, as reported from the latest census, numbers 29,721. Added to this is the University's regular semester attendance of about 12,000, and a summer school attendance of about 6,000. Then, too, the many athletic and other functions of the University brings to our city many additional thousands of guests throughout the year. Ann Arbor is a high class residential community, a city of shade trees and beautiful homes, with a people who take great pride (city wide) in their many fine lawns and gardens. In consequence there is a high per capita water consumption in Ann Arbor, the total demand approaching that of a city of about 45,000 population—as set forth in an article which follows these remarks.

Some History in Brief

For those of you who have never visited this beautiful city it will be difficult to believe, but, from the time the first privately owned water works was built in 1885, throughout municipal ownership since January 31st, 1914, and until the new water softening plant (to be described) was put in full operation in 1939, Ann Arbor was continuously confronted with a water problem. Efforts were made to provide a satisfactory supply from various artesian sources and from the Huron River. Numerous surveys, studies and reports have been made, seeking a solution of the problem, but none of these many efforts and ideas appeared to "click." It apparently was a case of too many cooks spoiling the soup. Finally, when it became evident that the financial position of the Water Department would permit the construction of a water softening plant from its surplus earnings, and without the necessity for a bond issue, a solution seemed at hand. That it was will appear later. Public water supply history in Ann Arbor began in 1885. In this year the Common Council entered into a contract on May 6th with a private corporation, known as the Ann Arbor Water Company, allowing the construction and operation of a water works system under a 30 year franchise. On January 31st, 1914 the system was purchased by the City and has since been municipally operated.

Commission Management

Some interest may be found in a City Ordinance passed in December 1913, preparatory to the taking over of the water system. It has not been altered since, except in a minor way, and the Water Department continues to function (happily) as then prescribed that it should.

The Water Works Ordinance of Ann Arbor, in brief, calls for the following method of operating the Water Department. It states that all business pertaining to the water works system of the City shall be transacted and controlled under the management and direction of the Water Works Department. Further, that the Department shall be operated and controlled by a Board of Commissioners consisting of three members elected by the Common Council for six year terms, staggered to expire two years apart in each case. The affairs of the Department are administered by the Manager who is hired by the

Board. The Department is responsible for the collection of all moneys due for the service rendered, such moneys being deposited in a special fund from which it is drawn only by order of the Board of Water Commissioners. Water rates, however, are established by the Council and in this ordinance the Council retains to itself complete jurisdiction as to water use *outside* the city limits. The Commissioners serve without pay, although until Ordinance amendment in 1933 each received $20.00 per month as compensation.

Ground Water Supply Proves Insufficient

Since May 1923 the artesian supply has had to be amplified by drawing from the Huron River in increasing degrees, until now the surface source accounts for about one-half of the City's supply at times, although much money has been spent in explorations for additional ground water and for the sinking of more wells. All of this has been done in attempts to meet the public demand for as nearly 100% well water as possible.

Improvements to the System

Improvements authorized in a 1931 bond issue, which were rapidly carried to completion, included the following: A new 6,000,000 gallon capacity, fully enclosed concrete box type, reservoir was built. This reservoir was built in three sections with provisions for cleaning one section at a time. By careful arrangement of the inlet and outlet pipes, provisions were made for insuring a uniform flow of water through the structure and a minimum of dead spaces. A complete system of drains were installed under the floor slab and around the side walls, and to date there is no evidence of any leakage.

Ann Arbor had experienced much dead-end trouble and, therefore, all dead-end mains were eliminated where it was physically possible to reasonably do so. Reinforcing mains were constructed to the high ground to the east and to the west of the city.

The presence of the new reservoir on the line resulted in immediate pressure improvements throughout the city. It provided the necessary reserve with which to maintain a more uniform pressure condition during the periods of heavy consumption, a condition that had long needed remedying.

These improvements, however, did not fully solve the water problem, but the presence of the reservoir did tend to almost entirely eliminate the necessity for the use of river water for the time being. Although the sentiment still appeared to be in favor of ground water, complaints began to mount concerning the quality of water being provided. Due to the necessity for maximum pumping from all available ground water sources, the water was becoming extremely hard. The presence of iron was becoming more and more a source of complaints, and the demand for an improved quality of water began to be more strongly felt.

The Softening Proposal Takes

In 1935, when it appeared that the demand had reached the point where determined action must be taken, the proposal for the construction of a water softening plant was advanced. From its reception it appeared that the time was ripe for action and authorization was granted

The New Softening and Filtration Plant of Ann Arbor, Mich.

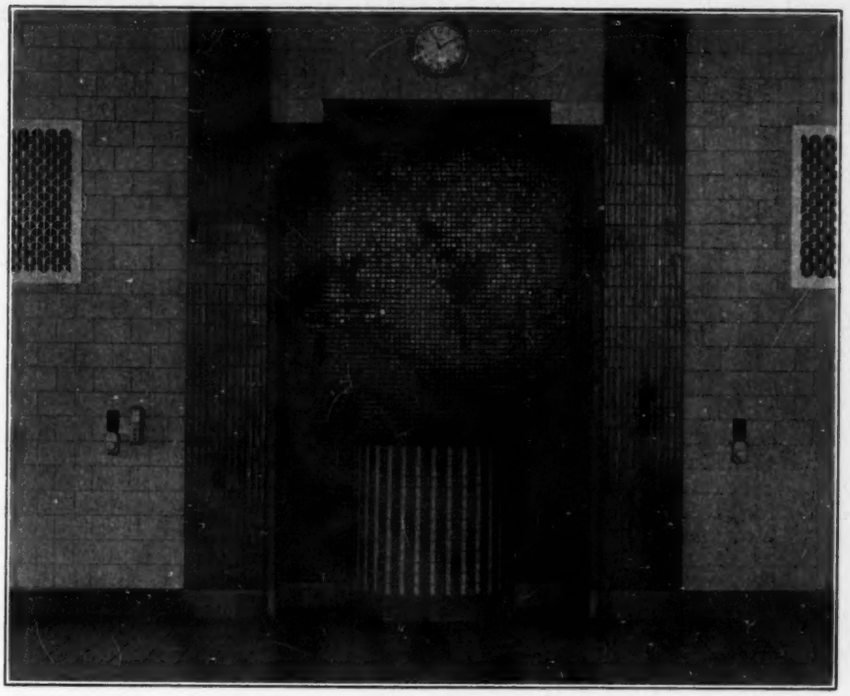
(For Details See General Plan and Flow Diagram Which Accompany the Articles by Messrs. Ayers and McEntee Which Follow This Article.)

for the filing an application for a P.W.A. grant for the construction of such a plant. However, after a two year delay this opening seemed to be gradually closing. Fortunately the financial position of the Department was very sound and it appeared that with a little help the project could be put on a cash basis.

When these facts were made sufficiently known, a strongly determined Board of Water Commissioners and an equally determined and cooperative Council put the idea "up for sale" and it was taken up by the public like a plate of hot cakes. Through an increase in rates of 50% for the one year (1936) an additional $72,000 was brought into the Department to make the water softening plan, including the plant and necessary changes in mains, a feasible project at a cost of about $525,000—and all paid for on a "cash and carry" basis.

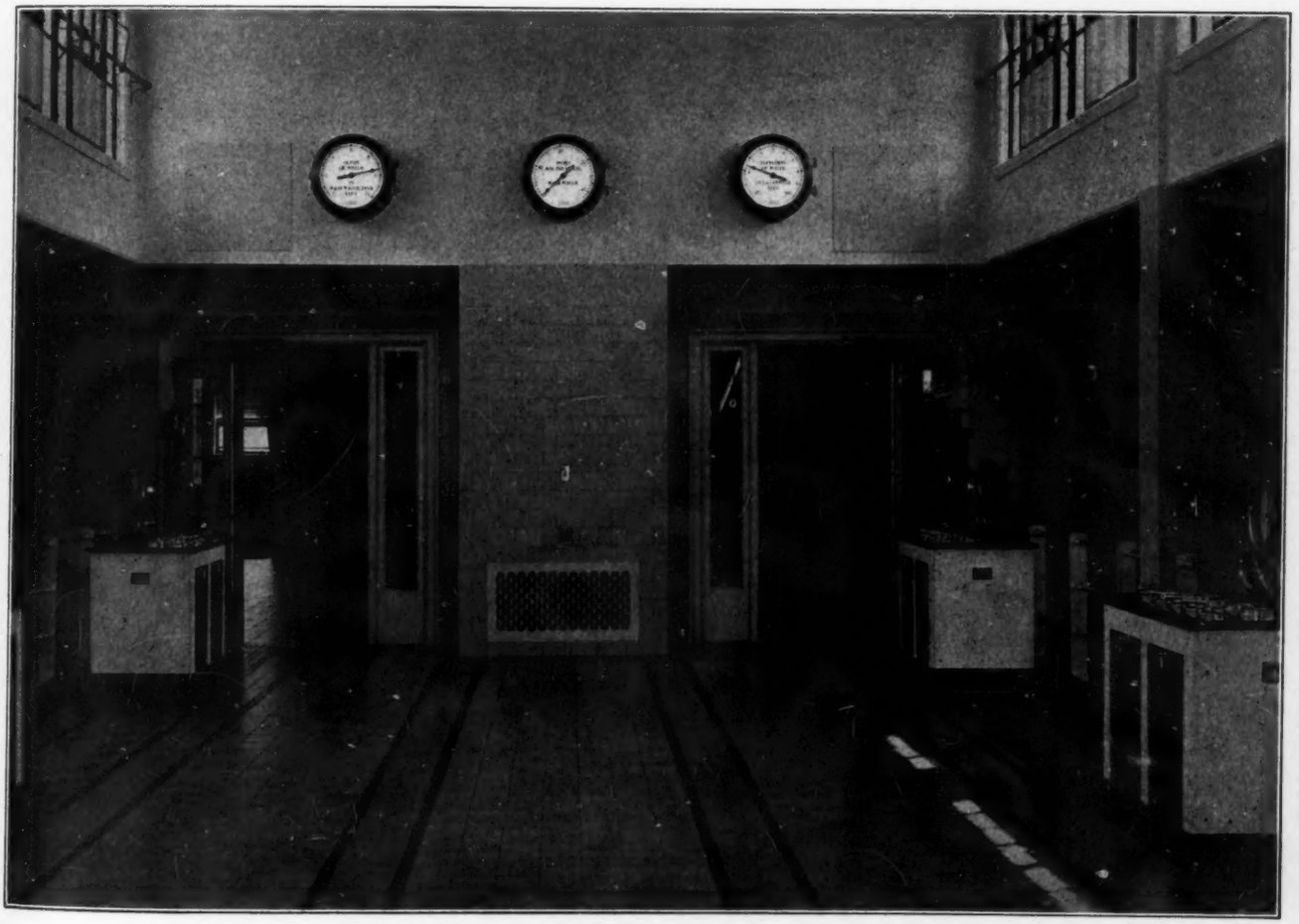
Realization

And today Ann Arbor has a softening plant of which it is truly



Rear Wall of the Entrance Lobby

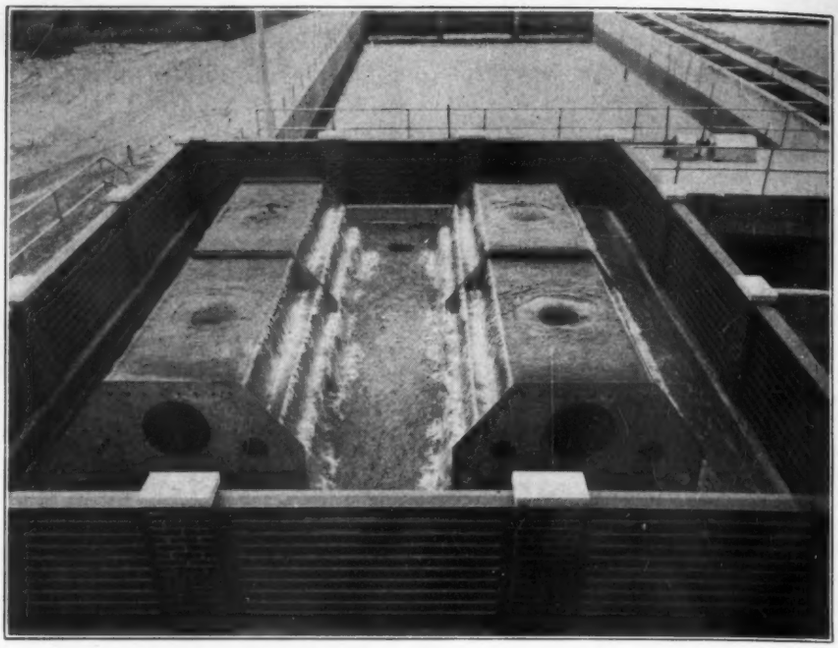
(Is Representative of Interior Architecture, Wall and Floor Finish Throughout the Plant)



End of Filter Operating Floor

(Looking Through Toward the Laboratories.)

proud. It is beautifully treated architecturally, interiorly and exteriorly, as the reader will see, and it is especially well engineered and constructed. The mechanical equipment is of the most modern and up to date type, and no expense has been spared in providing excellent laboratory facilities. The results obtained have been so completely satisfactory that, without reservation, it can be said that the construction of this water softening plant has solved the half-century old water problem for the City of Ann Arbor.



Raw Water Aerator
(Beneath is the 1st Rapid Mix and Primary Flocculator.)

The Supply and Its Treatment

The supply of Ann Arbor is derived from three widely separated artesian sources, with an auxiliary supply from the Huron River. The total hardness of water from the major artesian source runs about 420 ppm. and is high in iron content. The plant is located on the highest ground in this area, adjacent to the 6,000,000 gallon storage reservoir, from which water is distributed to the city by gravity.

This plant is designed and equipped for dual operation of softening by the lime-soda ash process, with special provisions for split treatment and return of sludge. The raw water is pumped directly to the centrally located plant from all sources and enters through a cascade type aerator. The first and second rapid mix chambers are of the impeller type. The primary and secondary flocculation basins consist of three baffled compartments, each equipped with three paddles operating transverse to the water flow. The primary and secondary sedimentation tanks are of rectangular shape with chain and scraper type sludge collecting equipment. Primary and secondary carbonation channels are equipped with brass pipe distributing grids. Filtration is by six-rapid sand filters of normal total daily capacity of 8,000,000 gallons when rated at 2 gpm./sq. ft. These units are equipped with conventional grid type collecting systems, concrete wash water troughs and with provisions for salvage of wash water, which is returned to the sedimentation basins. Carbon dioxide is provided by coke burning equipment. Chlorine can be introduced into the raw, partially treated and filtered water; chemical feed machines are of the gravimetric type. The plant receives chemical by truck shipment, has pneumatic unloading equipment and ample provisions for storing of all types of chemicals to be employed.

Design and Operation

Following this brief historical account and introduction, "Design Features" of the plant are presented in an article by Mr. Louis E. Ayers, Designing Engineer, of Ann Arbor. In another article, dealing with plant "Operating Experiences," Mr. Harry E. McEntee, Supervising Chemist in charge of plant operation, reveals experiences in operating the very flexible new plant and presents results attained in softening and filtering the mixed waters of Ann Arbor.

The two articles which follow have been derived from papers prepared by the authors for presentation before the Michigan Section of the Am. Water Works Ass'n. and Michigan Conference on Water Purification, meeting jointly in Ann Arbor September 11th-13th, just as this issue goes to press. Such use of these papers has been authorized by the Association.

*When arrangements were made between "*Water Works & Sewerage*" and Manager Casewell of the Water Department of Ann Arbor, for an article on the new softening plant the meeting in Ann Arbor had not been arranged for. Learning that this plant was to be featured on the program we saw no justification for having an earlier paper prepared for an issue in advance of the meeting. In consequence, we have waited preparation of the scheduled papers in order that these might serve a dual purpose.—L. H. E.*

THE SOFTENING PLANT OF ANN ARBOR

Design and Operating Features

By LOUIS E. AYERS, Designing Engineer*
ANN ARBOR, MICHIGAN

IN DESIGNING a plant to soften and filter the water supply of Ann Arbor, and in selecting the most satisfactory location for such a plant, both the present and possible future sources of supply had to be taken into consideration. Likewise, the already existing facilities for pumping, storing and distributing the supply was a matter of some consequence in the planning, which aimed at retention of all such facilities for their maximum value in respect to overall costs of production and distribution of the softened supply.

The Author

Available Sources of Supply

The existing sources of supply to be considered were:

1. A group of relatively shallow wells located about 2½ miles south of the City, known as the Steere Farm supply and capable of a peak delivery of about 3 MGD.

2. A single 26 in. gravel-packed well located at the westerly City limits, known as the Montgomery Well and capable of a peak delivery of about 2 MGD.

3. A single 26 in. gravel-packed well located one mile north of the City, known as the Barton Well and capable of a peak delivery of 1.5 MGD.

4. An emergency river supply from the Huron River, adjacent to the Barton Well and capable of supplying, during minimum river flow, at least two and one-half times the present requirements of the City.

The average pumpage in 1939 was 4.73 MGD, a per capita use of 118 gallons. On a maximum summer day the use exceeds 9 MGD, or 250 gallons per capita, and a maximum hourly rate in excess of 18 MGD has been experienced. This, notwithstanding the fact that every service is metered.

Plant Location and Type

After weighing many considerations those that governed most pronouncedly in locating the plant and choosing the type of treatment follow.

At about the center of the several sources of supply was a then relatively new storage reservoir of 6,000,000 gallons capacity, from which distribution mains radiate into the city. Hence, at or near this reservoir proved to be a logical location for the purification plant, if the mixed surface and ground supply was to be continued. From the standpoint of chemical quality, quantity and degree of contamination, the Huron River must be considered a satisfactory source of supply, so long as treatment is to be provided under any circumstance. Estimates indicated some financial advantage in complete abandonment of the several well supplies in favor of the river supply in whole. However, such a plan would have run contrary to the desires of a goodly portion of consumers who voted for a softened supply of well water. Also the final product in the form of softened river water would have been less satisfactory during the warmer seasons and during dry weather flows.

Plan Adopted

In the final analysis the overall best plan, and that adopted, was to locate a single purification plant at the central point adjacent to the existing storage reservoir and bring to it all supplies (well and river) then in use. This of course necessitated a plant capable of treating a combination of surface and ground water of the variable characteristics to be anticipated from such a combination under varying conditions of river quality and demand therefrom.

The plan, however, contemplates the use of well water to the extent that such is available, and relief for the wells during all periods when the river water is cool and of good quality otherwise. In other words, it was decided to proceed first with the development of a plant that would treat either supply, and to postpone until later the decision as to the ultimate source. In may be added that, under competent direction, the plan has succeeded; and, after nearly two years of treatment of the combined surface and well supply, the water problem of Ann Arbor is no longer an active public issue. The treated water has met with general approval.

Plant Design

The new plant was built on the highest ground available, immediately west of the existing centrally located covered storage reservoir. As this reservoir, with a water depth of 18 ft., is built largely above ground, it is necessary to pump all treated water from the plant clear well into storage, against an average head of about 20 feet.

The plant capacity was fixed on the assumption that provision should be made to meet a maximum demand of about 50% in excess of current demand; and this basis anticipated twenty years of growth. The design further provided for a future 50% increase of plant capacity by adding more filters and another unit for flocculation and settling.

The plant design incorporates standard practice in its several units and is effectively provided with the facilities necessary for its variable service. A brief description of the several units, the design bases, and equipment follows.

*Of Ayers, Lewis, Norris and May, Consulting Engineers, Ann Arbor, Mich.

[The complete flow sheet accompanying Mr. McEntee's paper in this group will prove very helpful in connection with the design description which follows.—ED.]

The mixing, settling and carbonation tanks are in duplicate units, and the hydraulics permits either series or parallel flow through these units to the filters. The primary and secondary sludges are handled in separate systems, so that either may be delivered to the secondary flash-mix or wasted to whatever degree may prove desirable.

Aerator

On entering the plant the raw water passes over the cascade-type aerator pictured. It is constructed of two sets of galvanized sheet steel pans, resting on a concrete collecting apron built above the secondary flocculation basin. In each set of pans the water falls 4'3", in three equal steps. The weir lengths of the successive steps are 40, 80 and 160 ft. respectively.

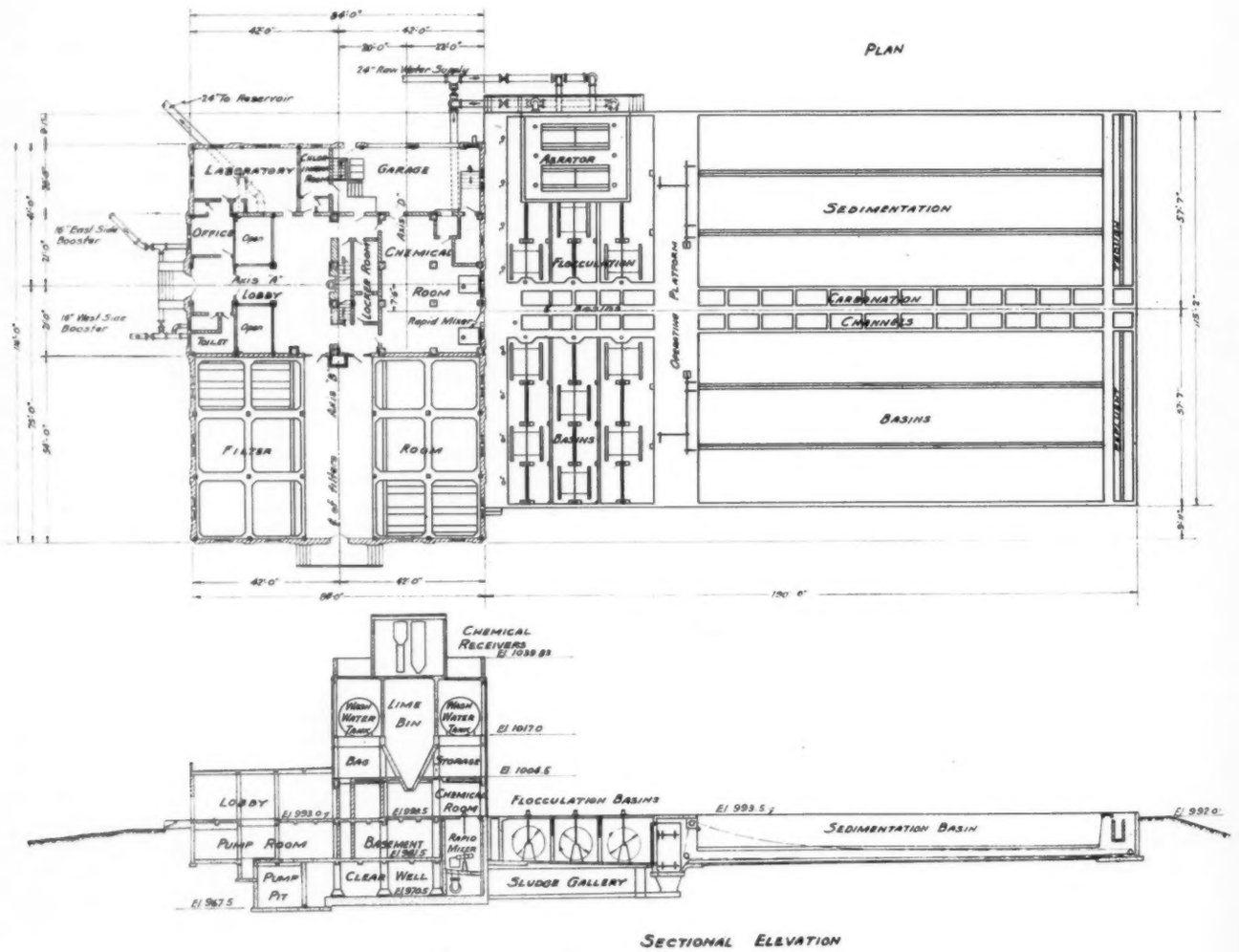
Flash Mixers

Two rectangular concrete tanks 10' x 10' in plan with 14' average water depth provide about one minute detention for a future maximum rate of 15 MGD. Each mixing tank has a vertical shaft mechanical agitator, 54" in diameter, similar to a centrifugal pump impeller but mounted at an angle with the shaft. Shafts rotate at 31 RPM and each shaft is driven by a 3 HP motor mounted on a vertical speed reducer. Water and chemicals enter the tanks at the bottom and the mixed water flows out at the top over a weir into the distributing channels leading to the flocculating basins.

Flocculators

Two rectangular flocculation basins, each 50' by 45' with an average water depth of 12', provide substantially 30 minutes of detention, each for 10 MGD.

The flow from the distributing channels to the flocculating basins is controlled through the manual operation of four 24" x 24" equally spaced sluice gates and the flow out of the flocculating basin is through a redwood outlet baffle wall of 2" x 8" verticals, spaced 3" apart. Each basin is divided into three sections by redwood baffles extending down from the surface to about one-half the water depth. In each section there is a horizontal steel shaft 50' long, driven, through bevel gears by a vertical gear-motor of one horse power, at 2.16 RPM. On



General Plan and Section Through the Softening Plant of Ann Arbor, Mich.

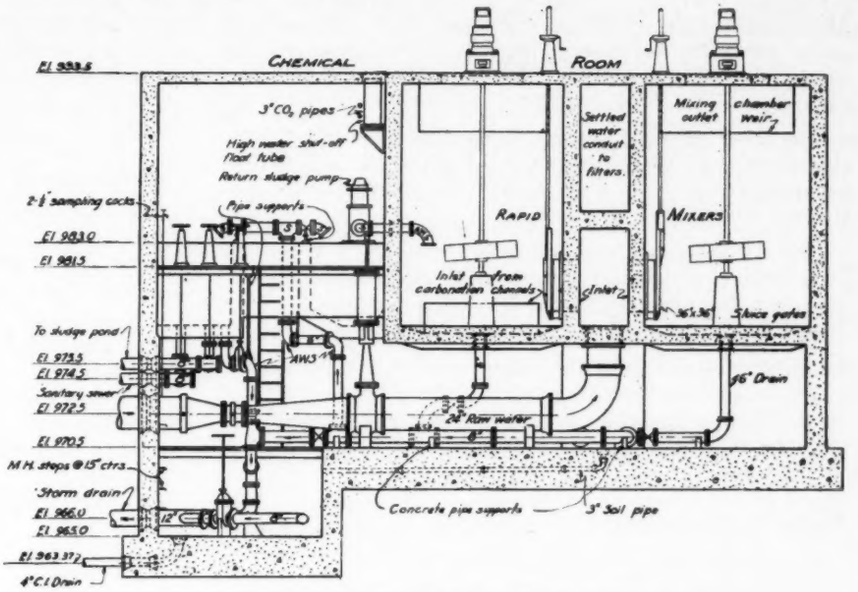
(Also See Flow Diagram Accompanying Mr. McEntee's Article Immediately Following. The Flocculators and Clarification Basins Are Subject to Parallel or Series Operation—the Latter Proving Best at Ann Arbor.)

this shaft there are four two bladed steel paddles 9'6" in diameter. These paddles rotate so that the bottom sweep is toward the inlet.

Settling Basins

Two rectangular settling basins, each 50' wide by 140' long, with an average water depth of about 12' provide 90 minutes of detention, each for 10 MGD. The inlet is through the outlet baffle wall of the flocculating basins, above referred to. The outlet is over a weir at the opposite end. Each settling tank is provided with three lines of straight line collectors and a cross collector into a sludge hopper at the inlet end, all driven by a single one horsepower motor. The 2" x 8" flights are spaced 8' apart and travel at the rate of 2' per minute.

The sludge from each basin is collected separately through cast iron sludge lines, leading through a gallery to the basement of the building. Sludge pipes discharge by gravity into either of two concrete inspection tanks, where throttling valves control the flow. From one tank secondary sludge may be pumped back to the secondary basin by a pump having a capacity of 100 GPM. The disposal of primary tank sludge will be discussed later.



Section Through the Rapid or Flash Mixers

(Note That Impellers Are Set at an Angle. To the 2nd Rapid Mixer Secondary Clarifier Sludge Is Returned to Effect Rapid Precipitation and Complete Stabilization—See Operating Results in Article by Mr. McEntee.)

Carbonating Channels

Running the length of the flocculating and settling basins (located between these basins), are two carbonating channels, each 180' long by 5' wide, with an average water depth of 12", providing about 11 minutes of detention for a flow of 10 MGD. Carbon dioxide gas may be distributed to the bottom of these channels through a brass pipe grid system with laterals spaced 2' apart, having 1/16" holes on 3" centers.

The gas may be supplied from the basement of the building by a coke furnace and scrubber with a capacity specified at not less than 3,000 pounds of CO_2 per hour. The blower has a capacity of 180 cu. ft. per minute at a pressure of 7 pounds per sq. in.

Chemical Handling and Feeding

Lime and soda ash are delivered to the plant by truck, since no railroad siding is available at the plant site. These chemicals are elevated about 50 feet into the tower by a dustless pneumatic conveyor system, having a capacity of 5 tons per hour, and dropped into rectangular concrete bins, whence they flow by gravity to the chemical feed machines. Three lime bins provide a total capacity of 200 tons, and the two soda ash hoppers have a total capacity of 30 tons. The lime storage was estimated as sufficient to meet the plant requirements for three weeks at a rate of 10 MGD of water, and the soda ash storage (a carload lot), is sufficient for six weeks or more.

Alum and activated carbon are handled in bags by an elevator to the second floor. The bag storage accomodates carload lots of these materials.

Three lime feeders of the weigh-feed type proportion and slake quicklime continuously, the milk of lime travelling through rubber hose to the flash mixer. Each lime feeder is mounted below a lime storage bind and each has a capacity of 500 pounds per hour. There are three smaller volumetric chemical feeders for soda ash or alum, each with a capacity of 50 pounds per hour, and each with one-ton hopper which may be loaded by spouts from the bins or from bag storage. Also, an activated carbon feeder is located in the bag storage room.

The Filter Plant

The plant contains six rapid-sand filters, each having a sand area 17' by 27' (459 sq. ft.), which provides a capacity of 7.5 MGD at the standard rating of 2 gpm/sq. ft. or 11.25 MGD at 3 gpm/sq. ft., which rate was expected to more nearly approximate experience under the conditions. The filters are arranged along both sides of a 20 foot wide gallery. Piping and structures are designed to provide for the addition of two more filters when that becomes necessary.

Filters

The filter beds are composed of eighteen inches of gravel, graded from 3" to 1/16", covered with 24" of Ottawa sand, with a mean effective size of 0.45 to .55 mm, and a uniformity coefficient of 1.20 to 1.40.

The underdrainage system is of cast iron pipe, with 3" laterals spaced on 12" centers with 3/8" brass bushed holes, staggered at 3" centers in the lower quarters of the pipe. The collector manifold is of 24" cast iron, laid in a trough in the filter floor and embedded in concrete.

The underdrains and laterals and wash water system are designed to provide a rate of wash water rise at 36" per minute for 5 minutes.

The filter gallery piping is of cast iron with the exception of the settled water conduit. The latter is forged steel, flanged pipe, 48" in diameter at the entrance to the gallery. It is coated inside and out, and covered on the outside with anti-sweat insulation. This conduit will have a maximum, eventual velocity of 1.8 ft. per second.

Washing Facilities

Wash water is supplied from horizontal water tanks in the tower, on either side of the chemical storage bins.

These tanks are 11′3″ in diameter, with bottoms 32′ above the sand surface in the filters, and have a total capacity of 48,000 gallons. The wash water pump has a capacity of 750 GPM, requiring one hour to fill the tanks.

The filter effluent piping discharges into water seal chambers with discharge weirs at a height sufficient to prevent formation of a vacuum in the piping or rate controllers.

The six filter rate controllers are connected to a totalizing device, which in turn actuates an automatic chlorinator for the sterilization of the filtered water.

The water from the chlorinating chamber flows into a small clear well under the main building, from whence it is pumped by one or more of three float controlled vertical pumping units, through an average head of 20′, into the 6,000,000 gallon storage reservoir already referred to.

Wash Water Salvage

The wash water from the filters drops into a cistern below the gallery floor of sufficient capacity to hold one filter wash. It is thereafter salvaged by pumping it to the flash mix. A small sewer is also available for the gradual release of this water, should such procedure prove desirable. Operating experience to date, however, indicates that this waste water is of value in the operation of the settling basins, and it is more economical to return the already softened spent water than to supply its equivalent from the raw water sources, involving more costly pumping in addition to the expense of chemicals for softening.

Disposition of Sludge

As already stated, the primary and secondary sludges are separately collected and brought by gravity to inspection tanks in the basement. The secondary sludge is returned to secondary settling. Three provisions were made relative to the disposal of the waste sludge: (1) Discharge into a sanitary sewer served by the Ann Arbor sewage disposal plant; (2) Diversion to a storm sewer emptying into the Huron River; (3) It can soon be discharged to settling ponds completely, or to whatever extent may prove desirable.
It can soon be discharged to settling tively small portion of the sludge output of the water plant could ever be handled at the sewage treatment plant which is of the activated sludge type employing sludge digestion. This because the dry weight of the water softening sludge will run over three times the dry weight of sewage solids.

It was thought, however, that a certain amount of lime sludge would be advantageous to the sewage plant, but experience to date indicates that only a limited quantity can be safely assimilated in the activated sludge plant. [This however is another story beyond the limits of this paper.]

In consequence, most of the sludge to date has gone to the Huron River, and although its point of entry into the river is well isolated from the public, complaints have been filed, and the city is under pressure from the Stream Control Commission to discontinue sludge disposal in this manner.

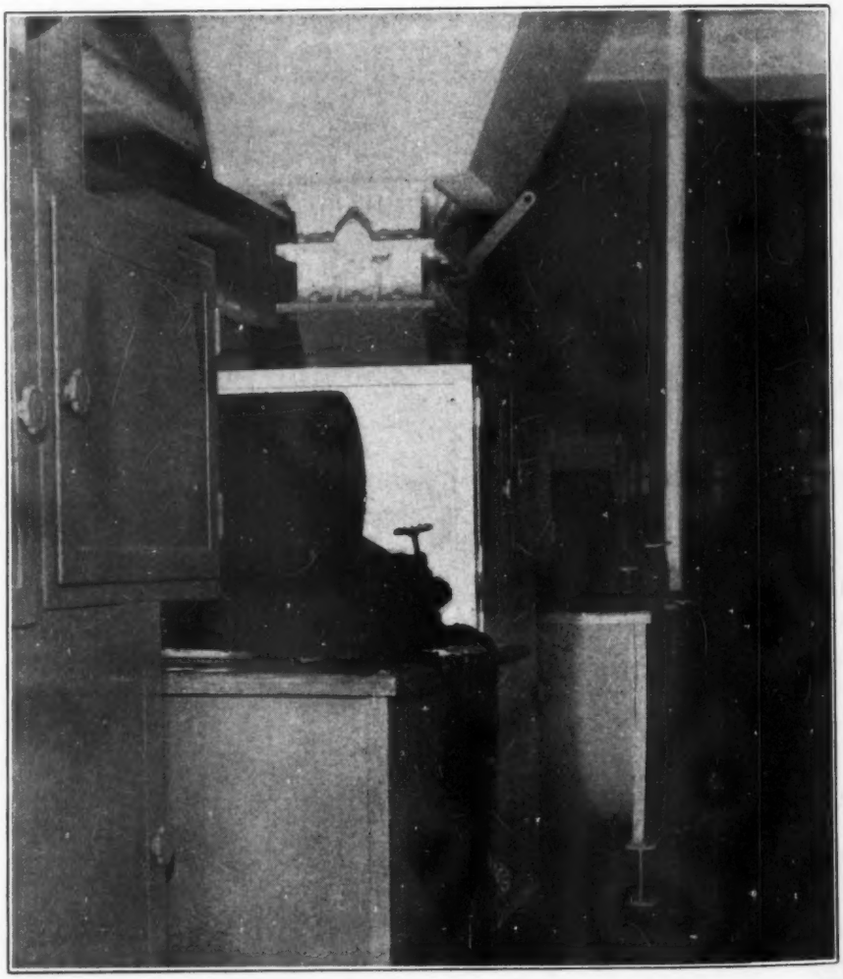
Sludge Pond

Fortunately there is a relatively deep ravine about 3,000 feet from the plant, into which the sludge will flow by gravity and in which sufficient storage volume is available to hold the solids for 20 years. Work is now in progress leading to the construction of a sewer to this area where the necessary lagoons for ponding are being constructed. It has been proposed that when there is an overflow from these ponds such may profitably be returned to the plant for re-use, as is now practiced in the spent wash water recovery scheme.

Architectural Treatment

The site of the new Softening Plant is the highest ground and in the choicest area in the vicinity of Ann Arbor for future residential development. With this consideration before us it was desired that the structure be of pleasing architecture and have attractive landscaping, but without extravagance. This we believe has been accomplished, as the pictures in a measure indicate without giving color effects.

The particular architectural features to be noted, however, are: First, that the brickwork is shaded from a



Lime Feeders of the Weigh-Control Type and Slakers

deep, dark red at the base course to a tangerine at the top of the tower. Secondly, the tower is flood-lighted by clusters of lights on the laboratory and filter-room roofs, and the penthouse is more brightly lighted from the top of the tower. The result is an incandescent effect from the distance and an interesting land-mark at night from the highways and airways approaching the city.—[On the cover of this issue is pictured a night view of this effectively illuminated plant.—ED.]

On the inside of the building, the floors and walls of the pump room in the basement and all of the main floor, lobby, laboratory, offices, and filter room are lined with tile, but only in the lobby, vestibule, and filter room floor were any decorative effects introduced. In addition, attractive aluminum railings are provided around openings and considerable attention was given to interior lighting effects. The additional cost of the tile work over painted monolithic concrete walls and floors was not a large item in the cost, and was thought justified from the standpoint of reduced maintenance and the advantages of increased attractiveness to visitors.

The tower of the building, accessible through easy stairs, is an interesting observation point which overlooks the Huron River Valley, the University of Michigan, Ann Arbor and its environs. This one attraction brings many visitors who otherwise would probably never see the new plant.

Costs

The plant proper, exclusive of raw water mains, cost $422,582.00. The cost of operation and maintenance, exclusive of power, was $33,398.52 in 1939, or $19.35 per million gallons of water treated.

Acknowledgments

The writer is pleased to have this opportunity to acknowledge the valuable assistance given by Mr. Arthur B. Morrill during the prelimianry studies, and by Mr. Eugene A. Hardin and Mr. James E. Wark in the preparation of the plans and specifications.

Great credit is due to Mr. Harry E. McEntee, Supervising Chemist, for the excellent operating results that have been achieved to date. The plant was designed and the construction supervised by Ayres, Lewis, Norris and May, Consulting Engineers, Ann Arbor, Michigan.

This article consists of parts of a paper presented by the author before the Michigan Section of the American Water Works Association, meeting in Ann Arbor, September 11-13, 1940.

SOFTENING THE ANN ARBOR SUPPLY

Operating Experiences During the First Two Years

By HARRY E. McEntee, Supervising Chemist
Water Purification Plant
ANN ARBOR, MICHIGAN

The Author

AS SET forth in the two papers preceding this one, the water supply for the City of Ann Arbor is obtained from three groups of wells, supplemented by water from the Huron River, in various quantities, when the characteristics of the river water are at their best—or, whenever it becomes necessary to relieve excess drafts on the ground water sources for any reason.

On this account the problem of properly adjusting the treatment of Ann Arbor's supply becomes the more interesting and flexibility of treatment facilities the more important. In this direction the results speak for themselves, the plant having consistently produced a product meeting critical demands of Ann Arbor's citizens who have all but forgotten their water quality troubles of many years previous running. And, with it, whims concerning the superiority of artesian water over the river supply have seemingly "gone with the wind," since a product so much superior to any purveyed heretofore in this City has been enjoyed by Ann Arbor citizens.

That all of this is so is a source of high satisfaction to those responsible for initiating, designing, and constructing, and also to us operating the new softening plant, hardly needs be said.

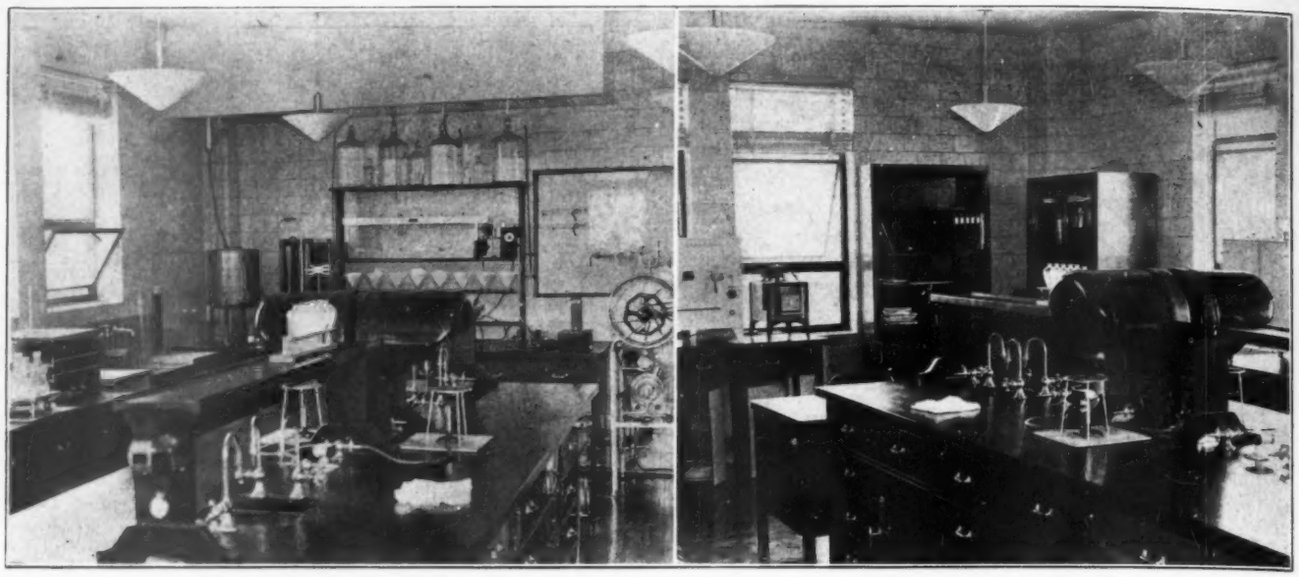
With the thought that some of our operating experiences and results attained may interest readers of this article, we are putting them down on paper.

Supply Characteristics

Representative composite samples of the well waters and the river supply reveal the following characteristics:

Ingredients (PPM)	*Wells*	*River*
Alkalinity, ($CaCO_3$)	250	315
Free CO_2	8	12
Magnesium	22	30
Iron	8	1.0
Hardness:		
(a) Non-Carbonate	60*	80*
(b) Total Hardness	310	395
Hydrogen Sulphide	—	0.8
Turbidity	*0*	*20*
Threshold Odor	*7*	*22*
Bacterial Count 37°	25	2,000
E. Coli Index	0	10,000

* Practically all being in the form of sulphates.



A View, Fore and Aft, of the Laboratory of the Ann Arbor Softening Plant

Four Methods of Plant Operation

As set forth in the paper by Messrs. Caswell and Ayers, the Ann Arbor plant is designed for separate operation of its two halves or series operation. Thereby the mixing, flocculation and clarification chambers may be operated in parallel or in series as conditions and results indicate the preferable method. As normal procedure series flow operation of the floc forming and settling units has become the standard practice. However, we have on several occasions dewatered different halves of the plant and during such times parallel flow has been employed for periods required. Operating with parallel flow there is little difference in the results attained in respect to effluent quality. However, the filters have imposed on them a greater load of suspended solids during parallel flow operation.

During the past year we have had the opportunity of trying out four methods of operation. Such are:

1. Conventional Treatment
2. Split Treatment
3. Split Treatment (with return of primary sludge).
4. Split Treatment (with return of secondary sludge).

By referring to the flow sheet, which appears further along, we can follow these methods of operation. (Also see the plan sketch of the plant which accompanies the preceding article by Mr. Ayers.)

Conventional Treatment

1. Raw water is raised a distance of 200 feet by high lift pumps to the cascade aerator.
2. Pebble lime is fed dry (weight control) into the temperature controlled slaking vat to form milk of lime. Soda-ash is dry-fed into a solution pot. Both chemicals are added to the water entering the 1st Rapid Mix. However, we can add soda-ash to the 2nd Rapid Mix when necessary.

1st Rapid Mix:—Herein the added chemicals are quickly and evenly dispersed throughout the water which flows therefrom into the primary flocculation basin.

Primary Flocculation:—The chemically dosed water now flows transversely through the Primary Flocculator having three flocculating paddles. Herein the water is stirred gently while the first chemical reactions are nearly completed as shown in the following equations:

(a) $CO_2 + Ca(OH)_2 \rightarrow \underline{CaCO_3} + H_2O$

(b) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow \underline{2CaCO_3} + 2H_2O$

(c) $Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow \underline{MgCO_3} + \underline{CaCO_3} + 2H_2O$

(d) $Mg\ CO_3 +$ Excess $Ca(CH)_2 \rightarrow \underline{Mg(OH)_2} + \underline{CaCO_3} +$ Excess $Ca(OH)_2$

(e) $Mg\ SO_4 +$ Excess $Ca(OH)_2 \rightarrow \underline{Mg(OH)_2} + CaSO_4 +$ Excess $Ca(OH)_2$

(f) $CaSO_4 + Na_2\ CO_3 \rightarrow \underline{CaCO_3} + Na_2\ SO_4$

$CaCl_2 + Na_2\ CO_3 \rightarrow \underline{CaCO_3} + 2NaCl$

The water now flows to the primary sedimentation basin.

Primary Sedimentation:—In this basin the precipitated compounds underscored in the above equations ($Mg(OH)_2$ and $CaCO_3$) are free to settle to the bottom to be removed by sludge collectors to the receiving hopper. From this point the sludge can be returned to the rapid mix or be discharged to the river. However, all wasted sludge will soon flow to lagoons which are now under construction.

1st Carbonation:—From this basin the flow is through the 1st Carbonation Channel, in which excess caustic alkalinity (mostly due to the soluble calcium hydroxide) is converted to insoluble calcium carbonate by the addition of scrubbed carbon dioxide gas, produced by burning coke. The reactions are:

(g) $C + O_2 \rightarrow CO_2$ (coke burning)

(h) $CO_2 + Ca(OH)_2 \rightarrow \underline{CaCO_3} + H_2O$

(i) $CO_2 + Mg(OH)_2 \rightarrow \underline{MgCO_3} + H_2O$

The small amount of $MgCO_3$ formed is soluble and remains in solution. To the extent that this compound is produced the water is "re-hardened" by recarbonation. However the overall results are very desirable.

2nd Rapid Mix:—Here any coagulant desired or activated carbon, when added, is rapidly dispersed through the water. Here also additional softening can be secured if desired.

Secondary Flocculation:—Calcium carbonate formed in the 1st recarbonation, or chemicals which are added, are stirred gently with the water in the basin to produce larger sized precipitates or secure effective contact.

Secondary Sedimentation:—Here most of the calcium carbonate, carbon, or other suspended matter settles, to be removed by sludge collectors either to the sewer or for return to the rapid mix.

Filtration:—The water which still contains suspended matter, calcium carbonate, carbon, etc., is clarified by filtering through 28" of sand and 18" of gravel.

All of the spent wash water is collected in a chamber for the purpose and pumped back to the secondary mixing units for complete salvage, productive of economy in chemical use.

After filtration the water is raised by low lift pumps to a six million gallon reservoir, where it flows by gravity back to the city.

Split Treatment

In Split Treatment recarbonation is discontinued and, instead, a portion of the raw water is added to the treated water in the 2nd mix. Here the excess caustic alkalinity in the overtreated portion of water leaving the 1st stage basins is converted to carbonate by the free and half bound carbon dioxide of the $Ca(H\,CO_3)_2$ naturally present in the raw water.

Sludge Return:—In Split Treatment, plus return of primary sludge, the treatment procedure is as above. But, in addition some of the primary sludge, which contains magnesium hydroxide and calcium carbonate, is also added to the water in the 2nd mix.

In Split Treatment, plus return of secondary sludge, the secondary sludge (containing mostly $CaCO_3$ and carbon) is added to the water in the 2nd mix.

Operating Results

Now that we have had a brief resume of the four methods of treatment used let us consider some of the results attained.

Conventional Treatment

(Table I—Column 1)

By referring to Table I, Column I, reveals operating averages when employing conventional treatment for the month of December. During this period soda ash was added to the 1st rapid mix.

1. *Aeration:*—There is practically no reduction in carbon dioxide because the carbon dioxide that is present in the raw water is initially low. Therefore, it is not expected that much reduction in carbon dioxide could be obtained. And, aeration *does not* reduce the odor in the Ann Arbor water.
2. *Primary Flocculation:*—The total alkalinity (as $CaCO_3$) has been reduced from 294 P.P.M to 115 P.P.M. as the water leaves this basin, 39 parts being carbonate and 76 parts being hydroxide.
3. *End of Primary Sedimentation:*—A slight drop in alkalinity across this basin, assumedly because of the additional precipitation of magnesium hydroxide.
4. *End of 1st Carbonation:*—Carbon dioxide gas has been added and all of the 71 parts of caustic alkalinity has been converted to carbonate alkalinity. The conversion is responsible for a dropping out of 21 parts (107 — 86) in the form of precipitated excess lime ($Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$), leaving a bi-carbonate alkalinity of 2 parts—i.e. (86 — 84). It is apparent that the samples did not contain all of the precipitate produced in the carbonation chamber or the total alkalinity would have been more nearly 107 and the carbonate (CO_3) 105.
5. *2nd Mix:*—Produces but slight change in the alkalinity. At this point 4 P.P.M. of carbon was being added.
6. *End of 2nd Sedimentation:*—The alkalinity has been further reduced by 29 P.P.M. because much of the calcium carbonate formed by recarbonation has settled in this basin.
7. *End of 2nd Carbonation:*—Carbon dioxide has been added and 32 of the 54 parts of carbonate (CO_3) alkalinity has been converted to bicarbonate (HCO_3) alkalinity in the reaction $CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$. Practically no reduction in the total alkalinity appears as was true in the first carbonation channel. Because of the small amount of calcium carbonate present a reduction is not to be expected.
8. *Filtered:*—The total alkalinity has been reduced 7 parts probably because a sufficient amount of carbon dioxide gas has not been added to the water in the 2nd carbonation channel. In addition, the water is still unstable and contains a colloidal alkalinity which has plated out on the grains of sand as it passes through the filters.

Had we added just a sufficient amount of carbon dioxide to the point where there is no drop in alkalinity across the filters, the alkalinity on the filtered water would of course have been higher than 46 P.P.M. and still more CO_2 would have increased the final product's alkalinity, by dissolving some of the carbonate coating on the sand grains.

No doubt we will find a lot of water softening plants operating today which operate with a drop in alkalinity across the filters, not necessarily for the economy obtained in using the filter sand as a softening medium, but out of necessity. In other words from the time that the raw water enters the plant to the applied water going to the filters we have two main problems:

1. The solubility of—and
2. The precipitation of $Mg(OH)_2$ and $CaCO_3$.

Even with ideal operating conditions it is difficut to obtain a low constant alkalinity because of the alkalinity which remains in a colloidal state and therefore does not precipitate out.

In the above case we have a total alkalinity of 84 entering the 2nd flocculation and sedimentation basins, theoretically this water should have a total alkalinity of about 25 P.P.M. as it is leaving the second sedimentation basin. However, we do not obtain such results because of the residual non-precipitated colloidal alkalinity.

Split Treatment

(Table I—Column 2)

4. *1st Carbonation:*—At the end of the primary settling basin the alkalinity has been reduced by precipitation from 309 parts to 85 parts. Practically no change in the alkalinity is noted through the 1st carbonation basin, because no CO_2 has been added.
5. *2nd Mix:*—The alkalinity has increased from 88 to 113 parts (100 being carbonate and 13 being bicarbonate) because the CO_2 and the HCO_3 (bicarbonate) alkalinity present in the raw water, here added to the treated water, is being converted gradually to a carbonate alkalinity.
6. *End of Secondary Sedimentation:*—The total alkalinity has been reduced 47 parts because some of the carbonates have been precipitated. However, the alkalinity is still high because of the colloidal alkalinity still in suspension or psuedo solution.

7. *End of 2nd Carbonation:*—No carbon dioxide added, and there is practically no change in alkalinity.
8. *Filtration:*—Total alkalinity has been reduced 22 parts, because the colloidal alkalinity is plating out on the filter media.

Split Treatment and Return of Primary Sludge

(Table I—Column 3)

4. *End of 1st Carbonation:*—From the aerated water to the end of the 1st carbonation channel the alkalinity has been reduced to 74 P.P.M. (240 parts reduction) by precipitation; no carbon dioxide has been added.
5. *2nd Mix:*—Total alkalinity (mostly carbonate) has increased during the 2nd mix to 90 P.P.M. One thing to consider in the returning of primary sludge, containing magnesium hydroxide, to raw water is the possibility that magnesium carbonate may be formed.

(j) $Ca(HCO_3)_2 + Mg(OH)_2 \rightarrow CaCO_3 + MgCO_3 + 2H_2O$

The $MgCO_3$ being soluble does not precipitate and therefore will cause a higher alkalinity and a greater residual hardness in the finished water. However, in this instance slow precipitation and colloidal alkalinity appears the explanation of major alkalinity increase, rather than conversion of $Mg(OH)_2$ to $MgCO_3$. Note that the alkalinity drops to 72 parts through the secondary basin, such being indicative.

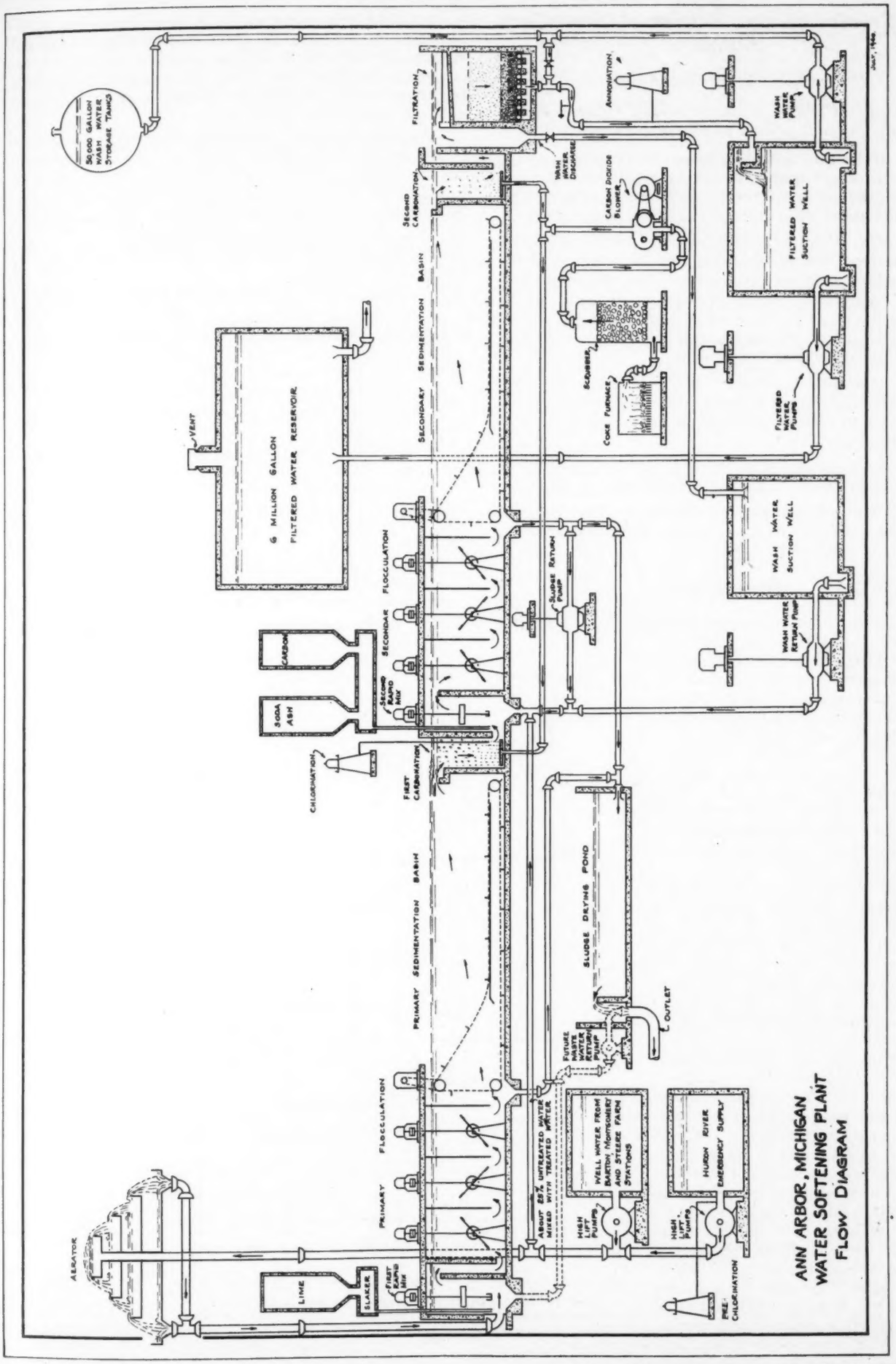
6. *End of Secondary Sedimentation:*—Only 18 parts reduction in alkalinity, although we observed that the water leaving this basin was the clearest we have ever had in the filters. The bottom of the basin, through 12 feet of water, was plainly visible.
7. *End of 2nd Carbonation:*—Not much of a change in alkalinity. No carbon dioxide is being added.
8. *Filtration:*—Alkalinity has been reduced 10 parts. However, the magnesium is about 6.8 PPM higher than the split treatment method without return of primary sludge.

TABLE I—COMPARISON OF METHODS OF OPERATION

Operating Results by Four Methods

Stations	Sample Analysis	1 Conventional With Recarbonation	2 Split Treatment Without Sludge Return	3 Split Treatment Return Primary Sludge	4 Split Treatment Return Secondary Sludge
	*Total Alk.	294	309	314	241
	Free CO_2	10	9	9	10
	Magnesium	27.6	29	29.1	24.3
(1) Aeration	Hardness				
	(a) Non-Carb.	60	73	62	78
	(b) Total	354	382	378	319
	P.H.	7.6	7.7	7.8	7.8
	Iron	.8	—	—	—
(2) Primary Flocculation	Alkalinity				
	Total	115	91	79	105
	CO_3	39	32	34	35
	$(OH)_2$	76	59	45	70
(3) End Primary Sedimentation	Alkalinity				
	Total	107	85	74	104
	CO_3	36	32	30	38
	$(OH)_2$	71	53	44	66
(4) End 1st Carbonation	Alkalinity				
	Total	86	88	74	103
	CO_3	84	34	30	37
	$(OH)_2$	0	54	44	66
(5) 2nd Mix	Alkalinity				
	Total	84	113	90	42
	CO_3	82	100	88	38
	$(OH)_2$	0	0	0	0
	HCO_3	2	13	2	4
(6) End Secondary Sedimentation	Alkalinity				
	Total	55	66	72	36
	CO_3	54	54	72	34
	$(OH)_2$	0	0	0	0
	HCO_3	1	12	0	2
(7) End 2nd Carbonation	Alkalinity				
	Total	53	64	70	36
	CO_3	20	48	68	32
	$(OH)_2$	0	0	0	0
	HCO_3	33	16	2	4
(8) Filtered	Alkalinity				
	Total	46	42	60	34
	CO_3	10	26	60	32
	$(OH)_2$	0	0	0	0
	HCO_3	36	16	0	2
	Magnesium	8.4	9.7	16.5	8.2
	Hardness				
	(a) Non-Carb.	51	34	55	58
	(b) Total	97	76	115	92
	P.H.	8.5	9.3	9.3	9.3
	Iron	0	0	0	0

* All figures for "Alkalinity" are in terms of PPM. $CaCO_3$ equivalents.



Flow Diagram—Ann Arbor Water Softening and Filter Plant

(Drawn to Indicate the Selected Method of Operation After Study of Four Possible Methods, With Split Treatment and Stabilization by Return of Secondary $CaCO_3$ Sludge to the 2nd Rapid Mix Recarbonation Has Been Discontinued.)

Split Treatment and Return of Secondary Sludge

(Table I—Column 4)

**Quite distinct from magnesia loaded primary sludge, secondary sludge is almost wholly of calcium carbonate.*

4. *End of 1st Carbonation Channel:*—At the end of the first carbonation channel alkalinity of the water has been reduced to 103 PPM (138 part reduction) by precipitation. No carbon dioxide has been added.
5. *2nd Mix:*—The total alkalinity has been reduced 42 PPM from 103 parts because of the addition of the secondary calcium carbonate sludge. Now here we have something; compare this result with results from the other two forms of split treatments. However, let us go on to the end with this method of treatment and then recapitulate.
6. *End of Second Sedimentation:*—There is a slight reduction in alkalinity because of the additional stirring of calcium carbonate sludge in the water in the secondary flocculation.
7. *2nd Carbonation:*—Practicaly no change in alkalinity. No carbon dioxide is being added; none is needed.
8. *Filtration:*—Practically no alkalinity drop is noted across the filters which is a good indication that the water is essentially stable.

Discussion

In order to obtain optimum results in the reduction of carbonate hardness, it is imperative that the magnesium be removed as much as possible, and to obtain the maximum magnesium removal we depend upon the law of mass action. By increasing the hydroxyl ion to the point of carrying causticity ($Ca(OH)_2$) to an excess magnesium hydroxide is produced so that it will precipitate (see equations (d) and (e)). Now, referring to the data from Split treatment with secondary sludge added (Col. 4), and starting at the end of the 1st carbonation channel, (4) we observe that the total alkalinity is 103 PPM, 37 being carbonate and 66 hydroxide. Now our problem is to convert this 66 parts of hydroxide alkalinity, which is in the soluble phase, to calcium carbonate which will largely be precipitated.

Suppose we add carbon dioxide gas for this purpose (see equations (h) and (i)). The 66 parts of hydroxide will be converted to 66 parts of carbonate. Therefore, we will have a total alkalinity of 66 + 37 = 103 PPM as carbonate. From this point up to the filters, we depend on precipitation of the carbonates formed to lower the alkalinity and per se the hardness. However, $MgCO_3$ is too soluble to be effectively removed as such. In addition some of the calcium carbonate is in a colloidal state and will not precipitate.

Now then in our raw water we have free carbon dioxide and a bicarbonate alkalinity (containing half-bound carbon dioxide). In the split treatment when we add this raw water to the treated water containing the hydroxide alkalinity, which we wish to convert to carbonate, let us calculate what takes place:

1. We have a total of 103 PPM alkalinity, of which 66 is caustic, or $Ca(OH)_2$ and 37 is $CaCO_3$ alkalinity in the treated water—all figures being in terms of $CaCO_3$.
2. We have 241 PPM of bicarbonate alkalinity in the raw water—also recorded as $CaCO_3$.
3. We also have 10 PPM of free carbon dioxide (CO_2) in our raw water.
4. Converting carbon dioxide over to the equivalent of calcium carbonate—(that is $\frac{100}{.44}$) we obtain 2.275 which is the conversion factor.
5. Then $(241) + (2.275 \times 10) = 263.75$ PPM of actual plus potential total alkalinity (as $CaCO_3$) in the raw water.
6. Alkalinity, as $CaCO_3$ in the raw is equivalent to alkalinity, as $CaCO_3$, in the treated.
7. $\frac{66 \times 1{,}000{,}000}{263.75} = 250{,}000$ gallons of raw water required to be added to 1,000,000 gallons of treated water, if all the alkalinity is to be converted to carbonate.

Theoretically all the total alkalinity of the mixed sample, at the moment of combination, should be greater

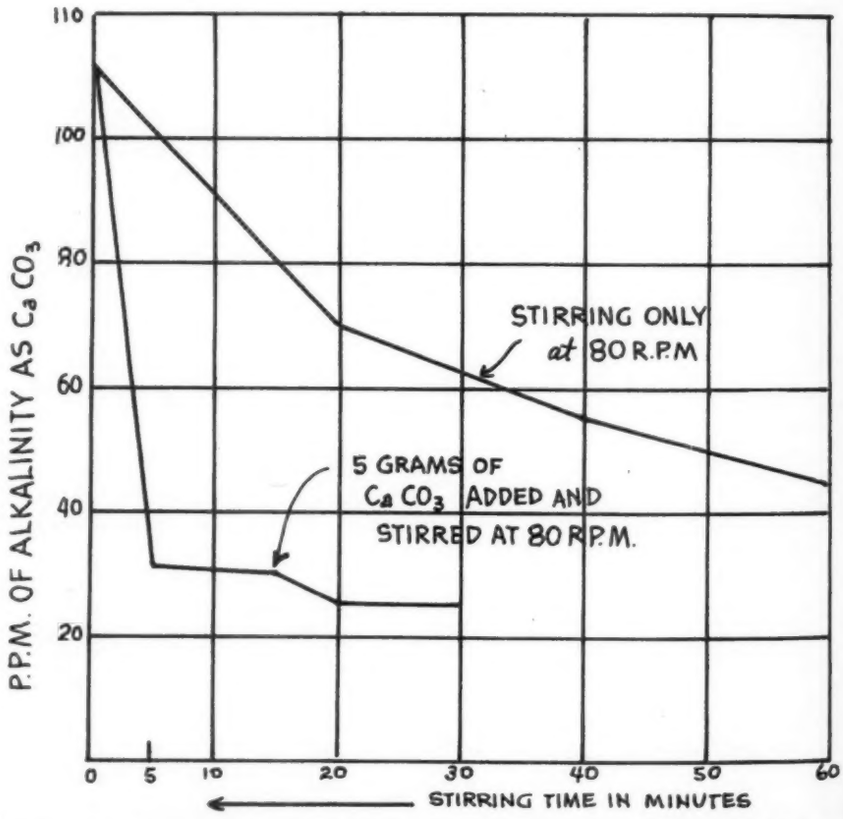


Fig. 1—The Effect of Adding $CaCO_3$ Sludge on the Speed of $CaCO_3$ Precipitation

(Results from mixing 25% raw water — alk. = 237 and free CO_2 10 ppm — with over treated water of 69 total alkalinity of which 35 parts consist of excess $Ca(OH)_2$. Stirring for various periods with and without $CaCO_3$ addition reveals some remarkable results.)

than 103 parts because of the added alkalinity formed by the addition of raw water. Also the combined waters should have an alkalinity where 2P = M.O. titration value, indicating 100% $CaCO_3$ alkalinity and no residual caustic alkalinity. The following steps constitute the calculations:

1. $1.0 \times 103 = 103$
   $.25 \times 263.75 = 66$
   169
2. $\frac{169}{1.25} = 135$ PPM total alkalinity expected in the mixed waters.
3. The phenophthalein alkalinity in the treated water is 84.5 PPM—ie. all of the 66 $Ca(OH)_2$ + ½ the 37 $CaCO_3$ alkalinity.
4. Then $1 \times 84.5 = 84.5$
   $.25 \times 00.0 = 00.0$
   84.5
5. And $\frac{84.5}{1.25} = 67.5$ PPM Phenol. alkalinity.
6. 2 P = M.O. (total alkalinity).
7. $2 \times 67.5 = 135$ PPM of total alkalinity.

This mixed water now contains a supersaturated solution of colloidal carbonate. No sludge has been added.

Experimental Demonstrations

Now before any sludge is added let us consider results from the demonstration pictured in Fig. 1, with and without sludge added in split treatment. Then in another demonstration the results of which are revealed in Fig. 2, we have the following observations:

1. If immediately after the raw water is added to the filtered water, the sample be filtered, the alkalinity is 107 parts. Therefore, there must have been particles of colloidal dimensions which have passed through the filter paper, but the filtered sample is sparkling clear, no particles in suspension being visible.
2. By stirring, and closely observing this sample, at the period of seven minutes there is a grayish color evenly dispersed throughout the liquid, due to the fact that particles of calcium carbonate are being formed. And, at fifteen minutes particles of sediment are observed. At twenty minutes there is not much of a change in the appearance of this sediment as observed after the fifteen minute period. However, by filtering a small portion and determining the alkalinity we find a reduction of 37 parts results.
3. After forty minutes of stirring the particles of sediment are much larger and have the appearance of the familiar alum floc. By filtering a portion of this sample a further reduction in alkalinity is observed. At sixty minutes there are fewer particles, but they are much larger. And, filtration shows a further reduction in alkalinity.
4. A microscopical examination of this precipitate at 430 magnifications reveals an aggregation of small crystals of indefinite shape—rounded, square, oblong, pointed—which are clinging together. By moving the mechanical stage back and forth rapidly we observe that single crystals or crystals attached together in pairs when coming in contact with other crystals will cling together tenaciously.

From the above experiment we have learned the following:

That stirring a supersaturated solution of water containing a colloidal calcium carbonate will cause the colloidal particles to grow from a submicroscopical state to a larger substance in the microscopical state.

This growth of particles will cause their precipitation and also will allow them to be removed by filtration.

Now with the above information in mind let us carry out the familiar stability test with $CaCO_3$ and parallel the test with other suspended materials. The results are pictured in Fig. 2.

By taking a sample of water, as used in the previous experiment, and adding 5 gms. of calcium carbonate, then stirring under the same conditions at 80 RPM, and filtering and titrating, we make the following observations:

That in five minutes time the alkalinity has been

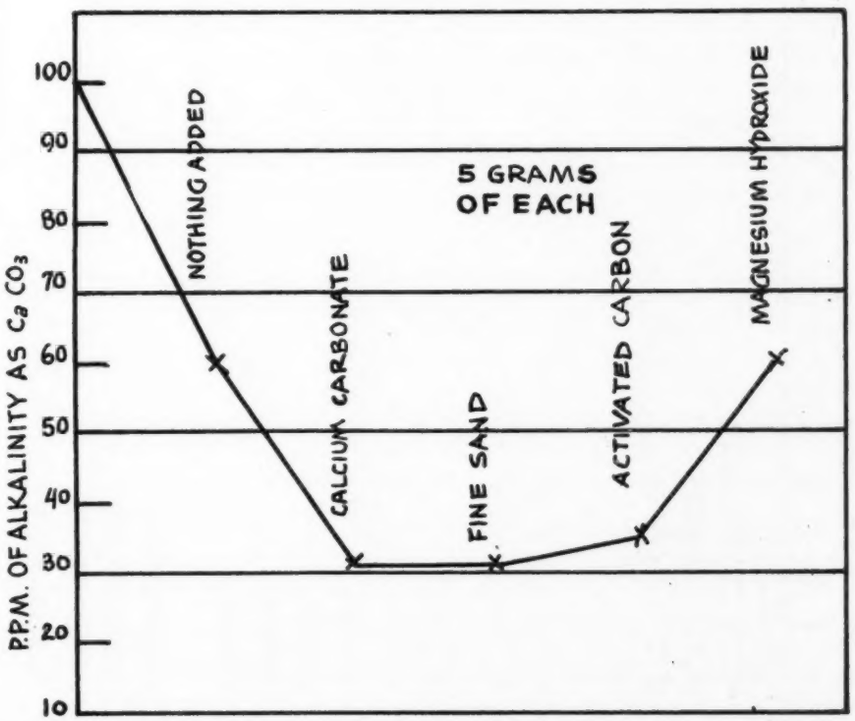


Fig. 2—Effects of Various Insoluble Substances on Speed of $CaCO_3$ Precipitation and Stabilization

(Results from mixing in 20% raw water of 275 parts alkalinity and 10 ppm. CO_2 with over treated water having 61 parts caustic alkalinity in the total of 99 parts. The graph reveals the subsequent effects of adding $CaCO_3$ and other insoluble materials followed by 20 minute stirring at 80 R.P.M. Note the effectiveness of activated carbon and even sand.)

reduced to 31 parts. At twenty minutes the alkalinity has been reduced to 25 parts. In other words the alkalinity has been reduced to the theoretical.

We have learned from the above experiment that by inocculating the solution with calcium carbonate, there is a tremendous removal of colloidal alkalinity in a matter of minutes. No doubt this reduction starts immediately after the calcium carbonate is added to the solution. It requires about twenty minutes using our apparatus to get the maximum reduction in alkalinity.

Now that we know that calcium carbonate which has a negative charge will remove colloidal alkalinity from water, let us try the following experiment. (See Fig. 2.)

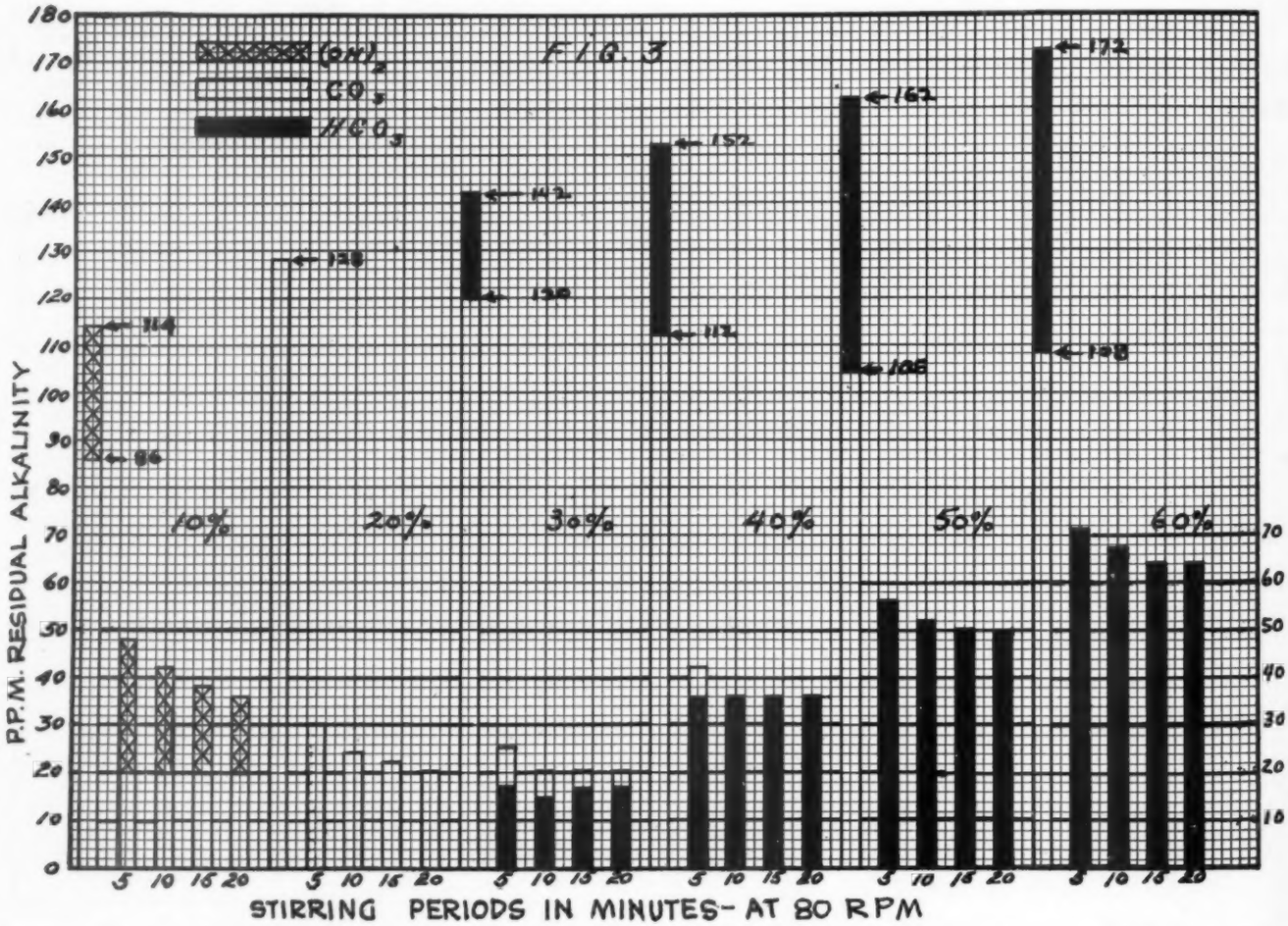
By using the stability test on a sample of water as described and employing various materials we make the following observations:

1. That fine sand and calcium carbonate are about equal in the removal of colloidal alkalinity.
2. Activated carbon will remove alkalinity; however, not quite as well as calcium carbonate and sand.
3. Magnesium hydroxide does not remove colloidal alkalinity but adds to it.
4. Activated carbon having a neutral to a positive charge will remove alkalinity nearly as well as calcium carbonate or silica sand, which have negative charges.
5. Magnesium hydroxide having an amorphous, jelly like consistency does not seem to remove the colloidal alkalinity.
6. It therefore appears that any particle having a hard solid surface will remove colloidal alkalinity when it is used under the proper conditions.

From observations to date it would be very convenient to make the statement that this reduction in colloidal alkalinity is due to the fact that particles of calcium carbonate added to this supersaturated solution absorb colloids on their surface thereby removing the alkalinity. However, much more has to be learned before making such a statement.

The most important factor is that there seems to be a quantitative correlation between the quantity of colloidal alkalinity removed and the quantity of particles added. Absorption probably is an important factor. If this is true the size of the particles and the velocity with which these particles are stirred in a supersaturation solution may reveal interesting data.

Another factor worth serious consideration is the crystallization and aggregation of particles through the



Results From Adding 10% to 60% Raw Water to Over-treated Water, Thereafter Adding $CaCO_3$ and Stirring 5 to 20 Minutes at 80 R.P.M.

(It is observed that a 15 to 20 minute stirring at 80 R.P.M. proved ample to complete reactions and effect stabilization, regardless of carbonate to bicarbonate ratios between 100/0 and 15/85 percent CO_3/HCO_3, when precipitated $CaCO_3$ is added. Further, that the most effective treatment of Ann Arbor water involves split treatment with secondary sludge return to produce a water of 3 to 20 ppm. carbonate alkalinity and zero caustic alkalinity.)

means of mechanical agitation alone. Work is now being done along both these lines.

There is one observation which is interesting and that is the growth that is sometimes attained by these particles. We have removed pebbles of material from the bottom of our mixing well which have been as large as ½ an inch in diameter. They are hard and resemble small pieces of gravel. By breaking one of these pebbles we observe a series of white, black, and grey rings. The black and grey rings, no doubt, represent the periods when a greater or less amount of activated carbon was used for taste and odor removal.

Here at Ann Arbor we have excellent results with 1½ per cent settleable solids which are continuously returning to our 2nd rapid mix. Here soda ash is purposely added to the 2nd mix because of the calcium carbonate which is precipitated in the reaction. (See Equation f.)

This freshly precipitated carbonate from the addition of soda ash plus the freshly precipitated carbonate from the addition of raw water is always forming a surplus of available sludge to continue this cycle for this method of treatment. Our wash water with its residue of this sludge is also returned to the 2nd rapid mix.

The Value of Suspended $CaCO_3$

Again referring to Table I, and comparing the drop in alkalinity between the 2nd mix and the end of the secondary sedimentation on all four methods of operation, it is interesting to note that in method 4, (return of secondary sludge) there is only a 6PPM drop in alkalinity. Therefore, it is not necessary to depend on 5 hours retention time for the precipitation of alkalinity, because this condition has been met in 3.7 minutes of rapid mix after the magnesium has been largely removed in the primary stage.

However, we do have a turbidity of about 5 PPM in the applied water, due to fine particles of sludge. Nevertheless, this appears to be of an advantage because this fine sludge seems to act as a "filter aid." Perhaps one of the physical advantages of calcium carbonate is that it is not as compressible as the usual floc particles ordinarily used in water purification, such as that of aluminum hydroxide. Also as the particles of calcium carbonate settle on and in the filter surface, they probably form a more granular mat with a larger void space than is obtained with alum coagulation, but sufficiently small to entrain fine turbidity.

Our plant obtains filter runs of 156 hours with an initial loss of head of 1 foot and a final loss of head of 4 feet at a 125 M.G.A.D. rate. Without the addition of any coagulant (this being the way our plant is operated) the turbidity on the finished water is only .2 PPM. However, if the filters are put in interrupted service and they are again started, a turbidity of 2 PPM is observed for the first five minutes of operation, then the water clears to normal.

After two years of operation our filter beds appear to be in excellent condition. The first 10 inches has a black appearance due to carbon. However, below this depth the sand is perfectly clean.

Net Accomplishments

Due to the addition of raw water to the 2nd mix, we have about 25 per cent more magnesium present in our filtered water than we would have by using conventional softening. However, by using the split treatment and return of secondary sludge, we find the following results:

1. We can produce a water with the lowest carbonate alkalinity consistently.
2. The water is stable even before filtration.
3. We do not have to use recarbonation.
4. The caustic alkalinity of the first stage is not wasted, as it is used for additional softening in the second stage.
5. A substantial saving is made in the cost of chemicals and electric power.
6. Lime requirements by using this method is about 20 per cent less than that required in conventional treatment.
7. Our average savings per million gallons will amount to:

$1.26	Lime
.45	Coke
.50	Electricity
$2.21	Savings per million gallons.

Another advantage in using the split treatment and return of secondary sludge method is the elimination of the operating difficulties experienced when using recarbonation. The raw water is the recarbonation and the only mechanical equipment required is a valve to regulate the amount of raw water to be added to the treated water in a well having good mixing facilities.

Producing a Stable Water of Importance

The next and most important step of all is to be able to add a sufficient amount of calcium carbonate sludge to this mixing well to stabilize the water. After a sufficient amount of sludge is added we can actually produce a stable water of a low alkalinity containing both a carbonate and a bicarbonate alkalinity, if desired.

Figure 3 explains this statement more clearly. In this experiment, 6 samples were set up each containing 1,000 ml. of treated water having the following analysis:

Methyl Orange Alkalinity	96
Phenolphthalein Alkalinity	78
Caustic Alkalinity	60
Carbonate Alkalinity	36

To each sample there was added from 100 to 600 ml. of raw water having the following analysis:

Methyl Orange Alkalinity	270
Free Carbon Dioxide	10

To this sample was then added 5 grams of calcium carbonate. All 6 samples were stirred at 80 RPM. The alkalinities were determined at intervals from 5 to 20 minutes.

The bar on the left of each series denotes the theoretical alkalinity which should be present in the sample. The analysis of this bar diagram reveals some interesting observations:

1. That it requires 20 minutes to obtain a maximum reduction in alkalinity under the conditions of this experiment. Therefore it would be good practice for our plant to use this standard for the future determination of stability.
2. That there is about a 50% reduction in causticity in the sample to which 10% of raw water was added.
3. That the sample to which 20% (200 ml.) of raw water was added, resulting in 100% carbonate alkalinity, shows the maximum reduction. Such is to be expected.
5. That in all the succeeding samples the residual and the initial bicarbonate alkalinity are nearly the same.

6. That in the samples which contain a carbonate and a bicarbonate alkalinity all of the carbonate will be removed, when a sufficient amount of raw water has been added.

In conclusion we here at Ann Arbor feel satisfied that the split treatment with return of secondary sludge is the most satisfactory method of water softening for our particular supply.

A Giant Beaker Performs the Stability Test

The next time you have an occasion to run a stability test with your stirring machine, refer to our flow sheet and examine the design of our 2nd rapid mix. Here you will find that our engineers have built a giant beaker and stirring machine. They have also provided means for isolating and returning valuable calcium carbonate to this giant beaker and stirring machine.

Operation Difficulties

Recarbonation

Here is a condition where one of the first expressions that we were taught in chemistry "No more and no less" still holds true, but unfortunately it is no easy matter to follow this expression when trying to manufacture carbon dioxide of a definite per cent showing a constant straight line on a graphical instrument. For these reasons:

The carbon content of the coke will vary.

A thick bed of live fuel is most desirable. However, when fresh fuel is added there is a drop in combustion. Then drafts have to be opened to meet this condition. The fresh fuel is ignited, then we have an increase in combustion which requires more regulating of drafts. The fire needs cleaning, an increase in combustion, and again regulation of drafts. We have found that even with a 30 minute time interval between furnace inspections it is very difficult to obtain satisfactory results.

Some carbon dioxide blowers have very little clearance between the impellor and casing and they will "freeze" if shut down even for one hour. This freezing is probably due to the carbon, iron, and corrosive moisture from the carbon dioxide which has a chance to form a bond between the impellor and casting. Therefore, it is a good idea to turn the blower over every 30 minutes for the first 8 hours after a shut down.

Just before shutting down recarbonation equipment which has been working under a pressure, it is good practice to blow the carbon dioxide to the atmosphere. If you neglect to do this the back pressure may, in reversing back through the blower, form a vacuum which will suck sludge into the carbonation grids.

You will find it very difficult to feed, let us say a 100 C.F.M. flow to the 1st carbonation line and 80 C.F.M. flow to the 2nd carbonation line, simultaneously from only one blower. Should you cut down on the 100 C.F.M. flow to meet a change in causticity going into the 1st carbonation channel, then there will be an increase in flow above 80 C.F.M. into the 2nd carbonation.

Let us assume that we have the carbonation just right; that is, to convert the causticity in the 1st channel to carbonate and also to convert the carbonate in the 2nd channel to the proper bicarbonate.

An excess of carbon dioxide in the 1st carbonation channel will convert some of the carbonate to bicarbonate which being in solution will not precipitate in the secondary sedimentation basin and also at this time in the 2nd carbonation channel an excess of carbon dioxide will convert an excess of carbonate to bicarbonate.

A deficiency will allow a caustic alkalinity to be present in the 1st carbonation channel which will not precipitate in the secondary sedimentation; and also at this time in the 2nd carbonation channel a deficiency is not converting a sufficient amount of carbonate to bicarbonate alkalinity and the water being unstable is plating out on the filter media.

Then visualize what happens when this caustic alkalinity reaches the 2nd carbonation channel. If the deficiency in the amount of recarbonation has been corrected to meet the condition at the previous time, this caustic alkalinity now present will then carry on through the filters.

Here we have an illustration of what actually occurs when there is a deviation in the correct amount of carbon dioxide required for maximum efficiency. You can also appreciate what the figures on the reaction record would be, especially in plants which frequently check alkalinities at their important stations on a definite time schedule.

Lime Slaking

Pebble lime is purchased on the basis of an available calcium oxide of 90 per cent. However, the analysis of the lime will vary from 75 to 92 per cent. This variation is probably due not to the quality of the raw product, but to the manufacture. Some lime is under burned which is detected by a black core in the center of the pebble, or the lime may be over burned which is detected by a grayish appearance on the exterior of the pebble. The lime manufacturers have their difficult operating problems in production of a high quality product, just the same as we have our operating problems in the production of a high quality product. By storing a series of shipments of lime, having a variable analysis in lime storage bins, it is obvious that the quality of the lime being fed to the slaker will not be constant. Therefore, the causticity at the primary flocculation will be either above or below the causticity desired.

Couple this condition up with the difficulties experienced in recarbonation and assume that both are occurring simultaneously, which is common, then you can appreciate some of the problems that occur in the operation of a water softening plant.

Much is yet to be learned about the proper method of slaking lime. Some unanswered questions are:

> The proper weight of water per pound of lime is still a question. Another is, what is the proper temperature to have in the slakers. Then, what per cent of unslaked lime is present in the milk of lime?

This matter of increasing the efficiency of softening through a better knowledge of lime slaking is an interesting problem that warrants further study in the field of water treatment—not alone in softening but also in pH and alkalinity adjustment such as is now so prevalently practiced.

[In regard to this closing challenge made by Mr. McEntee, the editors of WATER WORKS AND SEWERAGE are pleased to announce that such a study has been made at an outstanding plant. The results and several pointers in lime slaking are to be published in this magazine shortly. Like Mr. McEntee, we realize that such a contribution will have considerable value to many of our readers who may have realized less than Mr. McEntee the importance of high efficiency in lime slaking in the continuous feed process.—Editor.]

THE "HYDE-RO RING"

A Rubber Jointing Ring for Poured Pipe Joints Possessing Many Advantages

By RALPH H. HYDE*
CAMPBELL, CALIFORNIA

TO BEGIN at the beginning it seems desirable that I explain briefly the events leading up to this invention of a rubber substitute for unsanitary joint packings, which my friends say should very appropriately be called the "Hyd(e)ro Ring." In consequence I have had copyrighted the name "HYDE-RO RING" to be described herein.

I have been Vice-President and Manager of The Campbell Water Company for the past 25 years and during this period have been in close contact with pipe laying at all times.

The jointing material for our first cast iron pipe was Plumber's Oakum which was purchased locally. After our first cast iron pipe was laid it was flushed of dirt, dust, rocks, etc., and the house connections made, and all was well. This procedure continued until about 1928, or a period of about eight years. At this time several articles appeared in water works magazines relating to the troubles experienced by various water companies regarding water contamination caused by jointing material and packing in new mains. We had just laid several hundred feet of six inch cast iron pipe and were ready to connect the services to this line. Due to the above mentioned articles we secured the services of a chemist who found a small percentage of coliform organisms present. After two or three treatments with hypochlorite solution, the tests proved negative.

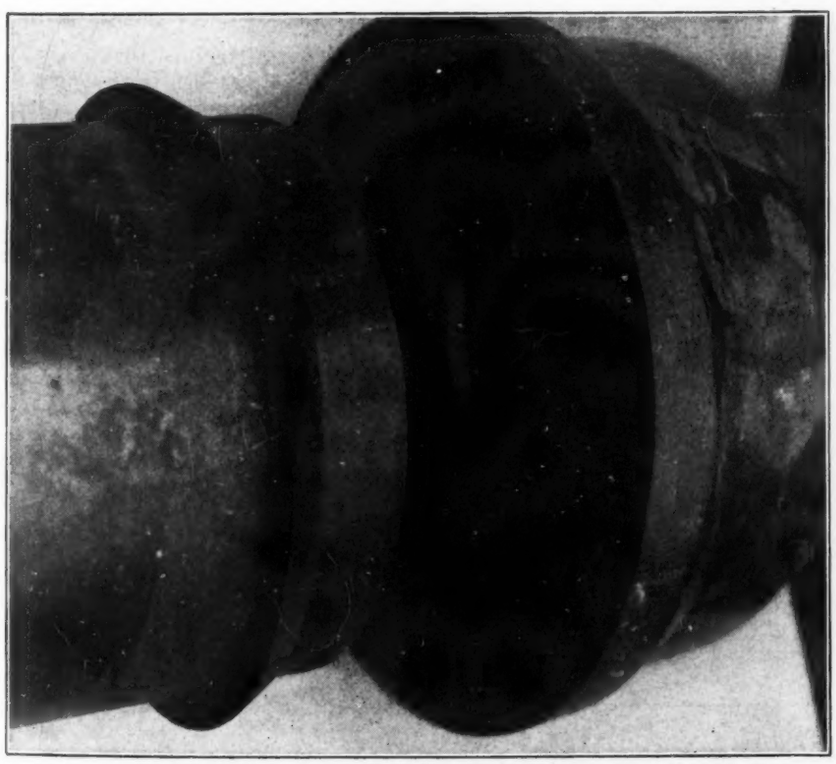
The Author

For several years after this we used various grades of jute or hemp, and followed the advice of our chemist in respect to treatment of all new lines with chlorine bleach. Some lines gave no trouble at all, but others would have to be treated several times before a negative test was secured. We found that as the years went by, our trouble from contamination increased and the length of time to clear up a line became longer.

Our Worse Experience

The climax to our troubles with new mains came in the spring of 1938, when it was necessary for us to lay several hundred feet of six inch cast iron pipe in order to supply the towns' new $250,000 high school. The line was completed in the month of May and tests were taken immediately after the line was properly flushed. These tests were positive, so we proceeded to treat the line as we had done before, with hypochlorite solution. We allowed it to stand overnight the first time, and then for progressively longer periods, because the tests were still positive. Some of the tests were negative immediately after flushing out the treatment, but we were still unable to secure a *permanent* negative test. We then proceeded to use 16% hypochorlite as it has more available chlorine than the household chlorine bleach previously used, but still without effect. A portable chlorinator was then secured from a neighboring city, and a treatment of five parts per million was given for a period of about thirty-six hours. A negative test was secured a few hours after flushing, but a second test taken within 24

* The author of this article is the inventor of the "Hyde-Ro Ring," as the name implies. He is a practical operator and now manager of the Campbell Water Co., Campbell, Calif.



"Hyde-Ro Ring" in Place on 8" Pipe Ready To Be Slid Home

hours showed the presence of coliform organism in just as great numbers as had been obtained before the use of the portable chlorinator.

This was in the early part of September 1938, and as the line could not possibly be cleared in time for the opening of school in the middle of September, an emergency line of wrought iron had to be laid from another direction. This line was completed and put into use only five days before school started. The original line was again flushed almost daily with various amounts of chlorine bleach, and not until early in February 1939 did the tests show a decrease in count of coliform organisms. Complete disappearance of this trouble in the latter part of February allowed us to put the line into use, but it was quite an experience.

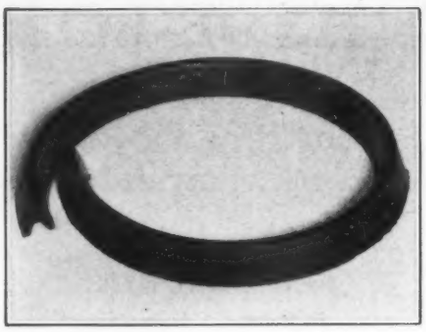
During those nine months of stubborn resistance, over a million gallons of water was wasted, a considerable amount of hypochlorite and chlorine bleach used, and an endless amount of labor and miscellaneous materials as well. In addition the emergency line had to be installed in the end, rather than take chances in serving school children the water of doubtful quality.

From early in 1939 until now the writer has been experimenting with rubber in various forms, shapes and textures as a packing for cast-iron pipe joints. Successful use of rubber gaskets for more than fifty years in wrought iron lines made us believe that there should be some method of applying it to cast iron pipe joints, thereby eliminating the use of the unsanitary jute or hemp.

What the "Hyde-Ro Ring" Is and Does

The rubber ring which I have perfected, has so far been used by our company in four, six, and eight inch cast iron lines, and all tests have been negative. Naturally we are enthusiastic about it, and feel that our exceedingly satisfactory experience with them warrants enthusiasm and something of a description of it and its advantages.

It is a rubber circular sealing ring, and is shaped like a wedge. From the narrow end, the wedge section increases in thickness to a point where it is equal to the space between bell and spigot. The ring is solid to this point; then the outside edges continue on to form a pair of lips or skirts which converge inwardly toward each other when the ring is caulked into the joint. The "V" recess between the two



One of the Rubber Jointing Rings

(Cut to show the Wedge, the Caulking and Compound Interlocking Groove and the Flaring Skirts.)

skirts holds the caulking tool during installation and has other attributes which become apparent.

The following features may be enumerated as distinct advantages for the "Hyde-Ro Ring":

1. *No contamination:* Since rubber does not harbor, nor is it a feeding place for bacteria, the use of rubber packing rings prevents contamination. This was the primary reason for its development, but others have appeared.

2. *Holds Back Water:* When starting a line from a fitting in service, the rubber rings fit tight and prevent leakage of water. Thus a wet joint can be made quickly and, therewith, results an appreciable saving in labor expense.

3. *Saving in Labor:* Because rubber rings are easily and quickly caulked into joints, a great saving of time is effected over the use of jute or hemp. A six inch ring can be caulked in one minute, no skilled labor being required.

4. *No Leakage of Compound in Joint:* The lips or skirts of the ring make a "bottle-tight" joint, and yet are flexible enough to absorb any irregularities in the pipe at the point of connection.

5. *Centers Pipe:* As the ring is caulked home it automatically centers the pipe into the bell because of its uniform nature.

6. *Skirts semi-vulcanized:* Any hot compound used with this ring will start the vulcanizing of the lips or skirts to the pipe and bell.

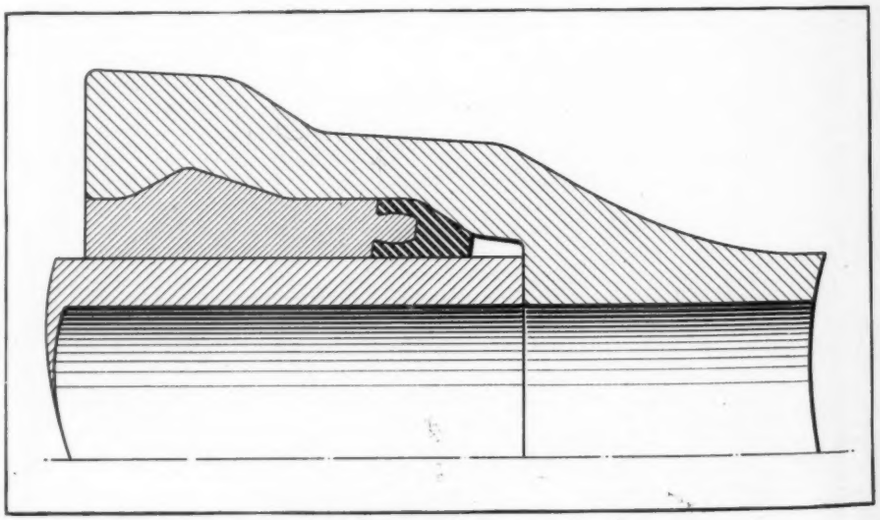
7. *Will Not Deteriorate:* The rubber is not exposed to heat, light, or air, hence should last indefinitely.

8. *No Expansion or Contraction:* Rubber rings will not expand or contract after a joint is caulked and poured, thus there are no after effects of jointing material being moved from its original position.

9. *Prevents Leakage from Sprung Joints:* Where a compound in a joint has been moved or compressed, due to an extreme jar or vibration, the rubber rings will prevent leakage in the joint, even though the compound has been disturbed.

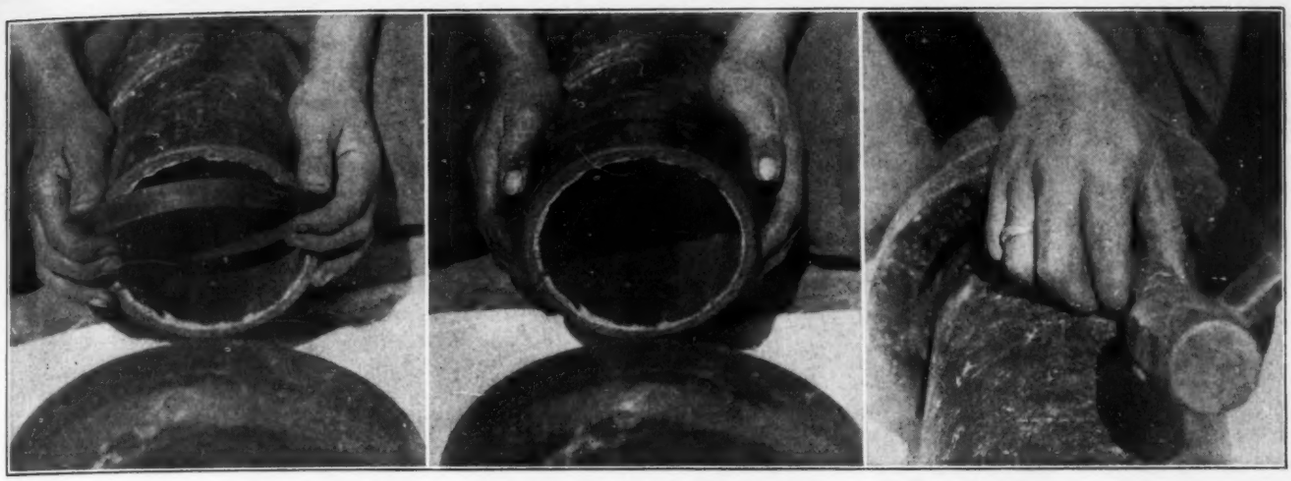
10. *Uniform Space:* The ring guarantees a uniform amount of compound around the pipe, which assures a better joint.

11. *Flexibility:* Regardless of the kind of compound used with this ring, it will greatly absorb any pipe line movement such as ground settling, quakes, etc.



Sketch of Joint Section

(Shows Ring in Caulked Position and the Interlocking with Poured Jointing Material or Cement Mortar.)



Making Up a Joint in Three Steps

(1) *The ring is stretched over the spigot end;* (2) *It is slid back about 1½ inches from the end;* (3) *The pipe is slid home for caulking into place with narrow tool, no skill being required in the operation. The joint is then poured in the usual manner.*

12. *Cylindrical:* On account of the ring being cylindrical in shape it will absolutely prevent any compound leaking.

13. *Interlocking Feature:* The ring is so constructed that it forms an interlock with the jointing compound used.

How the Ring Is Used

First: Stretch the ring over spigot end of pipe with narrow edge toward bell.

Second: Slide the ring about 1½ inches from end of pipe, then slide the pipe home.

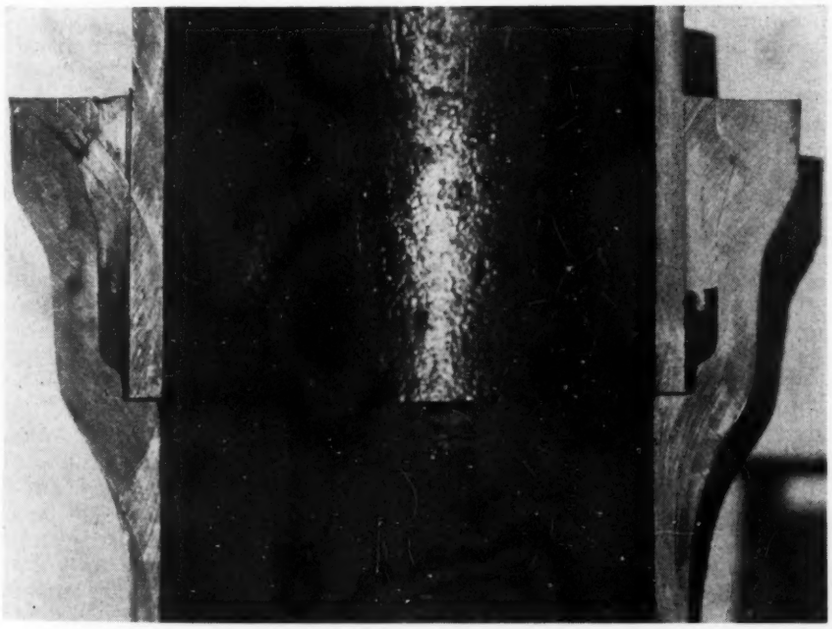
Third: Caulk the ring home, using a narrow caulking tool about ⅛ inch in width or less.

It can be used with any make or kind of compound: lead, cement, Mineralead, Leadite, Hydrotite, etc.

Our experience with this rubber ring has been all that we had hoped for, and we are positive that it has solved our problems of contamination. We are confident, therefore, that in order to get safe water at once from a newly laid line with rubber rings, it is only necessary to properly flush the line and treat immediately with commercial hypochlorite, or its equal, in order to remove possible contamination from the handling of pipe or fittings.

Recently we laid a six inch cast iron main approximately a thousand feet long, and flushed it as usual, in order to remove dirt, rocks, etc., and took a test. All tests taken at the point showed no count of coliform organism and the main was ready for use.

In conclusion, I wish to state that although rubber for the use of jointing materials is in its infancy, I believe that this is the real solution to the water works operator's search for a method assuring safe and sanitary jointing of cast iron pipe, as well as guaranteed tightness of joints even without skilled joint workers on the job.



A Sawed Section Through Actual Joint

(*It is to be noted that the gasket ring was not driven up as far on the right as on the left by the caulker. However, this makes little practical difference since water pressure forces the rubber outward to a close fit against the walls of the pipe.*)

Albert K. Warren Dies Chief Engineer and Organizer of Los Angeles County Sanitation District

Albert K. Warren, Chief Engineer and General Manager of the Los Angeles County Sanitation Districts with headquarters in Los Angeles, California, died on Wednesday, August 28 in a Los Angeles hospital after a brief illness.

Mr. Warren was born in Stoughton, Wis., on August 11, 1887; attended school in Illinois; practiced railroad engineering from 1910 to 1914, when he moved to Los Angeles and entered the employ of the Los Angeles County Surveyor.

In 1924 he organized the Los Angeles County Sanitation Districts for the purpose of disposing of the sewage from cities in the Los Angeles metropolitan area. Successful in this organizing venture, he was appointed chief engineer and general manager of the Districts, which position he held until his death.

A. M. Rawn,* long Chief Assistant to Mr. Warren has been appointed Acting Chief Engineer of the Los Angeles County Districts.

*Associate Editor of "Water Works and Sewerage."

1ST NATIONAL SEWERAGE CONVENTION COMES INTO HOME STRETCH

Attendance of 700 Seems Assured

Wm. J. Orchard
(Finance)

Anthony Anable
(Attendance)

Geo. J. Schroepfer
(Gen'l. Chairman)

C. K. Calvert
(Program)

Dr. F. W. Mohlman
(Arrangements)

B. A. Poole
(Pres. C.S.W.A.)

H. E. Schlenz
(Entertainment)

O. T. Birkness
(Exhibits)

LESS than a month away is the first National Sewerage Convention to be staged in this country. On October 3-4-5 the Federation of Sewage Works Associations will stage its initial convention at Hotel Sherman in Chicago. Plans now nearing completion anticipate an attendance of 700 or better.

Already at this writing (Sept. 1st) 39 exhibit spaces have been taken by 30 firms who will exhibit materials and equipment after the manner that such exhibits are put on in connection with the American Water Works Association.

The Technical Program has been released by Program Chairman Cecil K. Calvert, and will follow. It contains speakers of prominence from coast to coast.

Those behind this 1st Sewerage Convention, which is being held in conjunction with the Central States Sewage Works Association, have worked hard and the results to date speak for themselves. These "wheel horses" comprise the following Committee Chairmen:

Geo. J. Schroepfer (St. Paul)—General Convention
F. W. Mohlman (Chicago)—Local Arrangements
C. K. Calvert (Indianapolis)—Technical Program
Anthony Anable (New York)—Attendance & Publicity
H. E. Schlenz (Chicago)—Entertainment
O. T. Birkness (Chicago)—Manufacturers
J. H. Smith (Boston)—Exhibits
W. J. Orchard (Newark)—Finances
B. A. Poole (Indianapolis)—Pres. C.S.W.A.

Under the direction of Harry E. Schlenz of Chicago, working in harness with "Doc" Mohlman, a high grade program of entertainment is being developed, and in this direction plans are being made to see that everybody gets an opportunity to rub elbows with the other fellow, since this will be the first time that sewage workers have been brought together from the four points of the compass to a central convention.

The "Mystery" Clears

Since the "mystery" of why this Federation Convention and what the proposal to make the Federation more of a National organization "is all about" has now become much less of a "mystery", indications point to a larger interest and a larger attendance than was anticipated in the early stages. Chairman Emerson's Committee on Reorganization and Expansion has put the revised constitution and by-laws through the mill several times and, lately, the "refining process" has been applied. In the process the first indication of what dues would be required to finance a National Federation, with a central headquarters office, has been whittled down to a point where the so-called small operator will find the proposed membership dues, now based on size of plant, very much in his favor.

At the close of the Technical Sessions, in a half-day Business Session, the proposed Constitution is to be presented and the views of everyone interested heard.

Following this meeting the Board of Control, representing 25 Associations and 2750 members, will take some definite action based on *Vox populi,* so to speak. It may be that the constitution will be thrown back into the lap of the Reorganization Committee for revisions and circulation amongst the member associations before the Board feels that final action should be taken.

Be all of this as it may, the Federation has gotten off to an excellent start, considering the newness of the venture and lack of experience* in putting on such a National Convention. And, nothing but good can come of the movement, even though the launching of the enterprise on a National basis be tabled for a time.

*Herein a deal of credit must go to one Wm. J. Orchard who has worked closely (if behind the scenes) with the several Convention Committeemen, to help chart the course and pilot the ship where convention-managment experience is the only compass that can be depended upon.

The Technical Program

In examining the program it will be noted that the final afternoon is devoted to an arranged inspection trip to Chicago's Southwest Treatment Works—the "greatest of them all" amongst sewage treatment plants.

The "key-noter" on this program has been saved for the closing luncheon—something different, and something with a meaning which has not been disclosed. Although Dr. Abel Wolman, the most lucid and brilliant speaker in the sanitary engineering profession will "come late and leave early", we can guarantee that none of his hearers will wish to follow his example when they hear so polished and interesting a speaker as this distinguished educator.

Whereas many big names appear on this program the lowly operator will take his part in the "Operators' Breakfast" Session during which the "Round Table of Operating Problems" is to be held. Operators Mick and Tatlock, (Joint Leaders), are planning well to make of this period a real feature of the convention.

Exhibitors

The following firms* will exhibit equipment or materials:

Activated Alum Corp.	Link-Belt Co.
American Brass Company	Lock Joint Pipe Co.
American Cast Iron Pipe Co.	Mathieson Alkali Works
American City Magazine	Merco Nordstrom Valve Co.
Builders Iron Foundry	Nichols Eng. & Research Corp.
Carson-Cadillac Corp.	Pacific Flush Tank Co.
Chicago Pump Co.	Pittsburgh Equitable Meter Co.
Crane Co.	Public Works Magazine
Dorr Co.	Royer Foundry & Machine Co.
Dow Chemical Co.	Sewage Works Engineering
Engineering News-Record	U. S. Pipe & Foundry Co.
General Electric Co.	Wallace and Tiernan Co.
Homelite Corp.	Wailes Dove-Hermiston Corp.
International Filter Co.	Water Works & Sewerage
Johns-Manville	Yeomans Bros.

*The list continues to grow and before the Convention opens several more exhibits are contemplated, this listing being as of Sept. 1st only.

THE PROGRAM

October 3rd

Registration (From 9:00 to 10:00 A.M.)
Address of Welcome—William H. Trinkaus, Chicago
Response—C. A. Emerson, New York
New Developments in Activated Sludge Plant Operation —Gail P. Edwards, New York
Discussor—Don E. Bloodgood, Indianapolis
The Role of Sphaerotilus in Activated Sludge Bulking—C. C. Ruchhoft and John F. Kachmar, Cincinnati
Discussor—H. Heukelekian, New Brunswick, N. J.

Luncheon

Role of the Trickling Filter in Sewage Treatment—Max Levine, Ames, Ia.
Discussor—Linn H. Enslow, New York
New Operating Results in the Chemical Treatment of Sewage—Willem Rudolfs, New Brunswick, N. J.
Discussor—E. Hurwitz, Chicago
Sewage Flow and Composition and their Bearing on Treatment—A. M. Rawn, Los Angeles
Discussor—R. A. Allton, Columbus
Trade Waste Disposal Methods of Recent Development —E. F. Eldridge, E. Lansing, Mich.
Discussor—L. F. Warrick, Madison, Wisc.

Evening

Smoker and Get-Together

October 4th

Progress in Conditioning Sludge for Dewatering—Frank W. Jones, Cleveland
Discussors—Harry A. Faber, New York and C. E. Keefer, Baltimore
Mechanical Devices in Sewage Treatment—Lloyd M. Johnson, Chicago
Discussor—Chas. Gilman Hyde, Berkeley, Calif.
Sludge Gas Utilization—Ralph E. Fuhrman, Washington
Discussor—W. B. Walraven, Springfield, Ill.
Dual Disposal—Sewage and Garbage—Where does it Stand?—E. J. Cleary, New York
Discussor—L. R. Howson, Chicago

Luncheon

Instruction in Sewage Treatment—Gordon M. Fair, Cambridge, Mass.
Discussor—H. E. Babbitt, Urbana, Ill.
Licensing of Sewage Plant Operators—Charles C. Agar, Albany, N. Y.
Discussor—C. W. Klassen, Springfield, Ill.
Business Meeting of Central States Sewage Works Association. Presiding—B. A. Poole, Indianapolis

Banquet and ?

October 5th

Operators' Breakfast

Leaders—K. L. Mick, St. Paul and M. W. Tatlock, Dayton
Business Meeting, Federation of Sewage Works Assns.
Presiding—C. A. Emerson, New York

Luncheon Address

America's Streams Today and Tomorrow—Dr. Abel Wolman, Johns Hopkins University

"Chicago's Newest"

The Southwest Sewage Treatment Works
(A Conducted Tour of Inspection of the "Queen Mary of the Prairie")

"SEWAGE TREATMENT"

By Karl Imhoff and Gordon Maskew Fair

350 pages—$3.00

Publisher

John Wiley & Sons, Inc.

The review of this volume has been one of the major delights rarely afforded to book reviewers. Every now and then a volume appears which is compact in form and treatment, intelligent in balance, clear-cut in language and giving evidence of obvious careful thinking on the part of the authors. Many of these characteristics, of course, were normally to be expected of the two authors of the text under consideration. It is none the less gratifying to read a volume which packs into 350 pages pertinent balanced material, carefully sieved and adjusted to the requirements of the reader. The present reviewer considers it one of the fine productions of recent years.

The volume is intended, as the authors state, "to bring to the English speaking world briefly and simply the considerations and calculations that enter into the design and operation of modern sewage treatment plants." The task has been well fulfilled, as may be gleaned from the fact that the text is peculiarly appropriate for use by students and by experienced practitioners. The limitations of space prevent any detailed comments on the innumerable ways in which this text justifies the flattering comments noted. The reviewer cannot resist, however, pointing out some of its outstanding characteristics.

Chapter I, for example, is as skillful and comprehensive a statement of the problems and solutions with respect to sewage treatment as I have seen compressed into 22 pages.

The summary of methods of treatment on pages 3, 4 and 5 are excellent. The scheme of cross referencing this chapter in many places to more detailed observations in the remainder of the volume are additional indicators of intelligent sympathy with the readers' problems. Through this and all of the subsequent chapters, the authors feel restricted by orthodoxy from suggesting courageous departures in policy and practice which rarely creep into such texts. For example, it is refreshing to note that: "Engineers and operators should be warned by mounting costs against the inclusion of unnecessary measuring equipment and overly refined records. What is really needed is a reduction in the cost of sewage treatment so that its convenience and benefits may be extended to cover all requirements of clean and healthful living."

Likewise the text demonstrates its modern courage by this additional statement: "Employment of sewers for the full water carriage of garbage and offal from kitchens and markets appears to be a logical forward step in municipal cleansing; provided that simple and cheap means can be devised for so comminuting this refuse that it will not cause stoppage in the sewers." Many an administrative official might take this to heart.

Chapter after chapter pursues the same even tenor of careful consolidation of material with equally careful methods of presentation. Such tables as 6 and 7, dealing with the properties, costs, handling and storage of chemicals used in sewage treatment, suggest the energy and care with which material useful to workers in these fields can be prepared. Similar comments may be made with respect to tables 11 and 12, dealing with various characteristics of sewage sludge; table 23, giving approximately the composition of industrial wastes, and table 25, dealing with values of oxygen absorbed.

It is not intended to imply that no points of difference may be taken as to material developed throughout the text, but these represent differences in judgment not major to the primary uses of the text. Such differences in point of view are more than balanced by the intelligent and careful development of such material as is presented in table 26, dealing with the classification of receiving waters according to use and requisite quality.

The volume is well indexed and carries a carefully selected but comprehensive reading list, classified according to individual chapters and assembled in the back of the volume.

Abel Wolman.

GEORGE GASCOIGNE'S PASSING

Ends a Notable Career in Sanitary Engineering

George Gascoigne

George Bradley Gascoigne at the age of 56 was far from being an old man when he passed away in a Cleveland hospital on August 17th, for he received his Civil Engineering degree from Ohio State University—an *Alma Mater* always close to his heart—only in 1910. But he climbed the ladder of success early in his life to carve out a notable career as one of America's youngest consulting engineers in the sanitary field, and to build an organization which added prestige and fame to the name George B. Gascoigne—Consulting Engineer, which he later had changed to George B. Gascoigne & Associates. And that was the way that George Gascoigne saw things in this life. He energized his men and his motto was that of "live and let live", his policy that of recognizing ability to the extent that he wished his staff to rise to the plane of becoming his Associates—that was the man that was Mr. Gascoigne to some, but always just George to those who came to know him at all well.

He was born in Oak Harbor, Ohio, December 18, 1884. They christened him George Bradley and sent him to Ohio State University which graduated him a Civil Engineer in 1910. He went to work in the Division of Sewage Disposal of the City of Cleveland in 1912 and 10 years later established himself as a Consulting Sanitary Engineer at the age of 38, thereafter soon making a reputation for himself. After the death of the eminent George W. Fuller, Mr. Gascoigne persuaded Chas. A. Emerson of Fuller's staff to join with him and, therewith, George B. Gascoigne & Associates expanded and established a New York City office, with Emerson in charge. The import of this vision on the part of George Gascoigne is apparent when considering the number of important eastern projects which have since been handled through the New York office. Such include Springfield, Mass. —a $3,000,000 sewerage project; New Haven, Conn., a $1,300,000 sewerage project; and the proposed Philadelphia sewage treatment project on which the Gascoigne organization has just recently been retained.

The achievement, however, which brought the highest pleasure to George Gascoigne was his retention to design and supervise construction of the three sewage treatment plants of his home town—Cleveland, these projects running to better than $17,000,000. Some other important Gascoigne engineered sewerage projects were those of Muncie, Ind., Elyria, Marion, Delaware, Alliance and Ashtabula, Ohio, and Jackson, Mich. The sum total of projects, water and sewage, on which he was retained would likely run to a value of approximately $100,000,000.

George Gascoigne served as an expert witness before the Supreme Court of the U. S. in the famous Chicago Lake Division Case and later in the case of Activated Sludge Inc. vs. the Milwaukee Sewerage Commission.

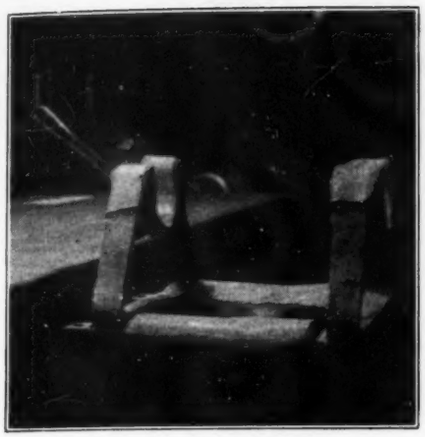
He was a member of the Am. Soc. of Civil Engineers, the Am. Water Works Ass'n., the Am. Soc. of Consulting Engineers, the Am. Public Health Ass'n., and other technical and professional societies. He was an ardent Rotarian and a member of Cleveland's Chamber of Commerce, and amongst his clubs were the Cleveland Country Club, Cleveland's Union Club and the Engineers Club of New York.

Mr. Gascoigne is survived by his wife, a daughter and George B. Gascoigne, Jr., a young Chemical Engineer associated with his father's firm.

"METER CRADLE"

Proves Handy Gadget in Repair Work

By DON CALDERWOOD, Engineer
Pennichuck Water Works
NASHUA, N. H.



"Meter Cradle" in Position
(Note protective lead coverings.)

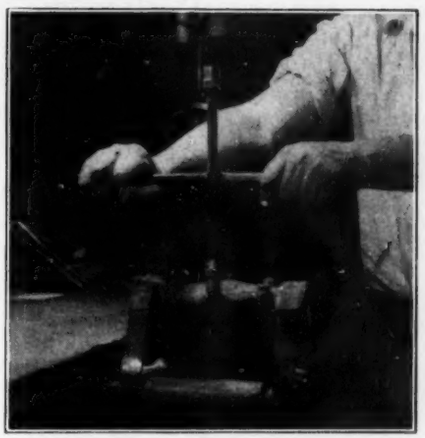
THE accompanying sketch and snapshots show a meter shop "gadget" that we designed and had fabricated in a local blacksmith shop.

This device not only speeds up the meter repair work but it also eliminates jammed fingers and skinned knuckles. The "U" part of the yolk should be covered with a piece of soft sheet lead to protect the threads of the meter spuds. We also found it advisable to bend another piece of lead around the two bottom bars from yolk to yalk.

The dimensions (given on the sketch) were worked out to fit almost any make and size of meter up to and including the one inch size. If any water works is fortunate enough to have only one make of meter, or largely one make, in service it is quite possible that slight modifications can be made to better suit the needs of that particular shop. With the sketch to follow no further description seems necessary, but the writer will answer any questions.

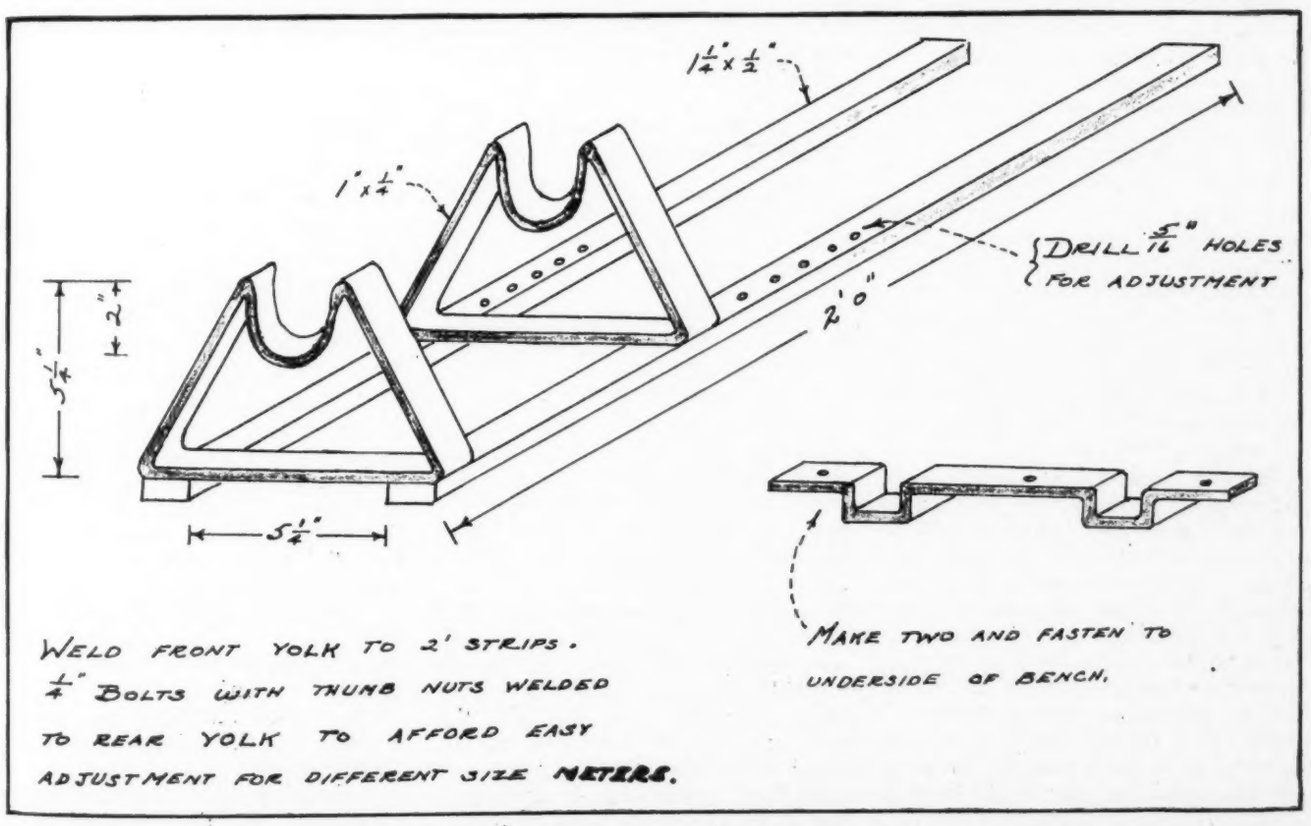
After the repairs are completed the gadget can be slid out from the under bench clamps and hung somewhere out of the way.

In connection with this gadget we developed a handy socket wrench. It is similar to the type of wrenches used in garages and filling stations to remove tires and wheels from an automobile. We first selected four sockets that fitted the various sized nuts of the meter casing bolts and then had these sockets welded to a + made from ½" steel rod.



—And in Use
(Featuring the handy socket wrench.)

Just another case where an investment of a few cents saves money, time, dispositions. And, in instances nicks in the shop man's anatomy.


1¼" x ½"
1" x ¼"
DRILL 5/16" HOLES FOR ADJUSTMENT
2'0"
2"
5¼"
5¼"
WELD FRONT YOLK TO 2' STRIPS.
¼" BOLTS WITH THUMB NUTS WELDED TO REAR YOLK TO AFFORD EASY ADJUSTMENT FOR DIFFERENT SIZE METERS.
MAKE TWO AND FASTEN TO UNDERSIDE OF BENCH.

Shop Sketch of Nashua "Meter Cradle"

SELF - INSURANCE BY A MUNICIPAL WATER UTILITY*

Experiences and Results After Twenty-Four Years

By J. ARTHUR JACKSON, Ass't. Treas.
Portland Water District
PORTLAND, MAINE

IT IS a fact that, operation, maintenance, construction, replacements and expansion in waterworks practice are all interwoven with accident and injury to such an extent that ways and means have to be devised to guarantee some provision to care for accidents and personal injury in almost every move or transaction in water works operation and improvement projects.

Two Ways of Providing Protection

There are two ways of providing the above protection and also protecting against loss of equity invested, through suit or damage awards. One is by some Insurance Company, contracted with to handle all claims and adjusted settlements. Such is done for specified sums based on the amount of the pay-roll, as illustrated in Fig. 1.

These sums, called premiums, must be paid regardless of the number or fewness of claims or settlements. This ratio of accidents to the amount of claims is the rate of premium plus the overhead and bookkeeping of the insuring corporation. No corporation can operate at a loss or give service for just plain cost or expense, and survive. And it is this statement that constitutes the key note of this paper.

Under the Workmen's Compensation Act, the Portland Water District is considered a municipal corporation and is permitted to carry its own insurance, and does. The benefits from doing so appear later.

The District sets aside each year, as nearly as can be estimated, that amount of money which would be required to maintain the necessary (and otherwise desirable) insurance through a regular Insurance Company. It performs its own insurance-fund bookkeeping, acts as its own adjustor, and assumes its own overhead. In this plan it has secured for the future a sum for contingent events, by setting aside each year funds equal to the premiums that would have to be paid an Insurance Company, and technically labeling it a "Reserve Fund." How the latter method was worked out I shall endeavor to show by fund records rather than give details over the 24 years that it has been in effect.

Since 1908, when the Portland Water District Board was organized, assisted by our present attorney, Mr. David Moulton, facts have proven that the citizens of Portland acquired the highest type of business experience and good judgment for future development. Therefore, is it any wonder that the Board realized the importance of accident and liability insurance, even though they felt at that time that the equity in the plant guaranteed the payments of all claims. And, as the equity increased so increased the security of payments of claims. This they held to be true because all reserves were carried in a single fund. However, this had to be revised.

An "Accident and Damage Reserve" Set Up

Under ruling of the Public Utilities, since July 1, 1915 all reserves have had to be shown separately. Thereby, it became necessary for the Water District to show several accounts and their amounts separately. So as of 1915, we made a start with an "Accident Reserve" of $2,970, apportioned with the approved policy of contributing $3,000 to this account annually. This continued up to 1927, when an "Injury and Damages Reserve" account was set up under the same process. It started with $1,663.40 and an approved policy of $2,000 to be added each year.

This policy was in effect until 1931. In this year it was felt the reserve was growing too rapidly, so only the "Accident Reserve" of $3,000 was set aside from that time. In 1937, this amount was further reduced and, instead of setting aside the lump sum at the end of the year, it was apportioned on a monthly basis of $100 a month—$1,200 annually.

Thus, for figures in the "Accident Reserve" we have a record from 1915 to 1939 inclusive as follows — (see Fig. 2).

$67,554.08	Total Deposited.—less
25,614.88	Used for Claims
$41,939.20	Balance—to which add
2,970.00	Initial 1915 Deposit.
$44,909.20	"Accident Reserve," Jan. 1940

Likewise in the "Injury Reserve" we have

$ 1.663.40	Initial Deposit
10,000.00	1927-1931 Deposit
$11,663.40	Total Deposited.—less
7,635.92	For Claims Settled.
$ 4,550.69	"Injury Reserve" Balance.

Hence, the total of these two accounts ($49,459.89) represents the saving, or profit, over all claims under the District Method.

Whereby We Save Almost $90,000

For a comparative analysis, I have selected the rates of a large Insurance Company who gave me the premiums at $4.50 a hundred for Shop Pay Roll and $2.11 per hundred for Office Pay Roll. This would produce accumulated premiums during the same period of:

$121,006.81	Total Premiums—deduct
31,064.19	Claims Paid by District.
$ 89,942.62	Profit to Insurance Co.

So we have an actual saving by our method of $49,459.89 over a period of 24 years, with a contribution of payments of "premiums" for self-insurance of $77,554.08 as compared to premiums to the Insurance Co. of $121,006.81 and no return or saving but all loss. In other words by impounding only 64% of the insurance cost we have paid all claims and saved 62% of our original contributions. Also we have now ceased to contribute to "Injury Reserve" from 1931 to 1939 and have dropped off $1,800 from "Accident Reserve" for 1937-1938-1939.

This brings us to the very definite conclusion that the Portland Water District's method certainly is a pro-

*This paper was read before the Maine Water Utilities Association, and is reproduced by permission.—Ed.

fitable method of taking care of accident liabilities and injury and damages. It scores another victory for the Trustees for a clear perception of business ability and thoroughness of understanding of the future as well as the present day's facts. Also let me add that the greatest aid in the success of this achievement has been the legal advice and the adjusting of claims, for which great credit is due to Mr. David E. Moulton, Atty. for the Portland Water District since its formation in 1908, and organizer and continuing president of this Association since.

We present the accompanying records covering Portland Water District's two insurance funds since 1915, for comparison with the study made of what purchased insurance would have cost the Water District over the same period of years. We offer these records for study and analysis by any who may be interested in the matter of providing adequate insurance protection for water works utilities.

INSURANCE COMPANY

Shop Payroll $4.50 *per* 100.00	*Office Payroll* $2.11 *per* 100.00	*Total Premium*	*Accident Claims Paid*	*Injury Claims*	*Total Claims Paid*		*Gross Profit*
$2,301.61	$581.53	$2,883.14	$1,193.40		$1,193.40		$1,689.74
2,147.76	578.34	2,726.10	52.79		52.79		2,673.31
2,088.27	538.46	2,626.73	206.08		206.08		2,420.65
2,549.28	850.91	3,400.19	382.75		382.75		3,017.44
3,308.21	910.59	4,218.80	365.50		365.50		3,853.30
5,368.11	878.34	6,246.45	853.17		853.17		5,393.28
5,331.88	905.66	6,237.54	1,331.75		1,331.75		4,905.79
4,607.38	1,067.90	5,675.28	783.90		783.90		4,891.38
5,140.58	1,170.07	6,310.65	1,229.00		1,229.00		5,081.65
4,656.94	1,254.69	5,911.63	271.09		271.09		5,640.54
4,560.60	1,116.59	5,677.19	223.00		223.00		5,454.19
6,498.08	1,776.58	8,274.66	801.43	$336.60	1,138.03		7,136.63
4,041.37	1,284.23	5,325.60	2,478.91	274.13	2,753.04		2,572.56
3,746.81	1,309.33	5,056.14	1,737.35	610.21	2,347.56		2,708.58
4,969.86	1,453.75	6,423.61	1,602.34	977.03	2,579.37		3,844.24
5,264.89	1,687.56	6,952.45	700.72	166.11	866.83		6,085.62
3,187.17	1,485.66	4,672.83	2,693.52		2,693.52		1,979.31
2,172.75	1,363.40	3,836.15	2,435.50		2,435.50		1,400.65
3,154.90	1,286.08	4,440.98	1,478.66		1,478.66		2,962.32
3,671.75	1,044.55	4,716.30	951.64	1,131.27	2,082.91		2,633.39
3,561.79	986.66	4,548.45	1,454.97	235.48	1,690.45		2,858.00
3,537.40	1,197.95	4,735.35	679.64	474.19	1,153.83		581.52
3,586.95	1,525.87	5,112.82	255.89	452.00	707.89		4,404.93
4,203.33	794.44	4,997.77	1,451.88	792.29	2,244.17		2,753.60
$93,957.67	$27,049.14	$121,006.81	$25,614.88	$5,449.31	$31,064.19	Ins. Profit	$89,942.62
						Dist. Profit	46,489.89
						Total Profit	43,452.73

Fig. 1—Computed Costs for Similar Protection to That in Fig. 2, if Purchased from Insurance Companies

	ACCIDENT LIABILITY RESERVE				INJURIES AND DAMAGES RESERVE				TOTALS		
	Acc. & Lia. Reserve	*Increase*	*Claims Paid*	*Contribution to Reserve*	*Injury and Damage Reserve*	*Increase*	*Claims Paid*	*Contribution to Reserve*	*Total Contribution*	*Total Claims*	*Gross Profit*
15	$2,970.00										
16	5,730.68	$2,760.68	$1,193.40	$3,954.08					$3,954.08	$1,193.40	$2,760.68
17	8,677.89	2,947.21	52.79	3,000.00					3,000.00	52.79	2,947.21
18	11,471.81	2,793.92	206.08	3,000.00					3,000.00	206.08	2,793.92
19	14,089.06	2,761.25	382.75	3,000.00					3,000.00	382.75	2,617.25
20	16,723.56	2,634.50	365.50	3,000.00					3,000.00	365.50	2,634.50
21	18,870.39	2,146.83	853.17	3,000.00					3,000.00	853.17	2,146.83
22	20,538.64	1,668.25	1,331.75	3,000.00					3,000.00	1,331.75	1,668.25
23	22,754.74	2,216.10	783.90	3,000.00					3,000.00	783.90	2,216.10
24	24,525.74	1,771.00	1,229.00	3,000.00					3,000.00	1,229.00	1,771.00
25	27,254.66	2,728.91	271.09	3,000.00					3,000.00	271.09	2,728.91
26	30,031.65	2,777.00	223.00	3,000.00					3,000.00	223.00	2,777.00
27	32,330.22	2,198.57	801.43	3,000.00	$1,663.40	$1,663.40	$ 336.60	$2,000.00	5,000.00	1,138.03	3,861.97
28	32,751.31	521.09	2,478.91	3,000.00	3,389.27	1,725.87	274.13	2,000.00	5,000.00	2,753.04	2,246.96
29	34,013.96	°1,262.65	1,737.35	3,000.00	4,779.06	1,389.79	610.21	2,000.00	5,000.00	2,347.56	2,652.44
30	35,411.62	.1,397.66	1,602.34	3,000.00	5,802.03	1,022.97	977.03	2,000.00	5,000.00	2,579.37	2,420.63
31	37,710.90	2,299.28	700.72	3,000.00	7,635.92	1,833.89	166.11	2,000.00	5,000.00	866.83	4,133.17
32	38,017.38	306.48	2,693.52	3,000.00	7,635.92				3,000.00	2,693.52	306.48
33	38,581.88	564.50	2,435.50	3,000.00	7,635.92				3,000.00	2,435.50	564.50
34	40,103.22	1,521.34	1,478.66	3,000.00	7,635.92				3,000.00	1,478.66	1,521.34
35	42,151.58	2,048.36	951.64	3,000.00	6,504.65	−1,131.27	1,131.27		3,000.00	2,082.91	2,048.36
36	43,696.61	1,545.03	1,454.97	3,000.00	6,269.17	−235.48	235.48		3,000.00	1,690.45	1,545.03
37	44,216.97	520.36	679.64	1,200.00	5,794.98	−474.19	474.19		1,200.00	1,153.83	520.36
38	45,161.08	944.11	255.89	1,200.00	5,342.98	−452.00	452.00		1,200.00	707.89	944.11
39	44,909.20	−251.88	1,451.88	1,200.00	4,550.69	−792.29	792.29		1,200.00	2,244.17	
						$7,635.92					
	$44,909.20	$41,939.20	$25,614.88	$67,554.08	$4,550.69	−3,008.23	$5,449.31	$10,000.00	$77,554.08	$31,064.19	$49,827.00
											−3,337.11
Contribution Acc.				$67,554.08		$4,550.69					$46,489.89
Contribution Injury				10,000.00			Saving to Date,			Bal. on hand	2,970.00
Total Contribution				$77,554.08			$44,909.20				$49,459.89
Less Paid Claims Accid.		$25,614.88					4,550.69				
Less Paid Claims Injury		5,449.31					$49,459.89				
		$31,064.19					121,006.81	Straight Ins. Co. Prem.			
							31,064.19	Claims Paid			
							$89,942.62	Gross Profit			

Fig. 2—Self-Insurance Records of Portland Water District Covering a 24 Year Period

OLD DOMINION SECTION MEET AT UNIVERSITY OF VIRGINIA

Virginia's Famed Rotunda Now Houses the University Library

THE Old Dominion Section of A.W.W.A. has just held another inspiring meeting on the campus of Thomas Jefferson's University in Charlottesville, Va.—a custom begun last year.

On the campus of the University of Virginia, noted for its atmosphere of serenity and charm, and its historical background, the Virginia Section held its 7th Annual Meeting September 5th and 6th.

The majority of the 110 attending were quartered in what are perhaps the most luxurious dormatories on any campus, the very minor charge for such accommodations "at cost" being included in the registration fee. The scheme in general is that so successfully used by the Pennsylvania Water and Sewerage Works Associations for the past several years at Pennsylvania State College. Its chief end is that of providing operators an opportunity to attend these centrally located meetings at a minimum of expense. In addition, there is much that is inspirational in the holding of meetings in such centers of learning.

Divertisements

The only divertisements in connection with the meeting was golfing on the forenoon before the official opening of the meeting, and the cocktail hour and picnic-dinner served out at Fry's Springs Park.

After the dinner an interesting movie film in technicolor—"Behind Your Water Tap"—was shown by E. A. Sigworth of the Industrial Chemical Sales Div. of W. Va. Pulp and Paper Co. This proved to be one of the films which have been produced by staff members of Mr. Sigworth's company for the purpose of loaning these to water works men for use in giving popular talks before civic organizations and the like, in order to show local citizens something of what is behind their water taps besides a pipe line and a pump. We wish to take this opportunity of complimenting the producers of this quality film —in particular Messrs. Welch and Haywood, in their work as cameramen.

Chairmen

(Retiring)	*(Incoming)*
Wm. G. Myers	*R. W. Fitzgerald*
City Engineer	*Sup't. Filtration*
Harrisonburg	*Norfolk*

Officers

At the closing business meeting D. R. Taylor, Chairman of the Nominating Committee, presented the following names to fill offices for the year ensuing. The election was unanimous:

Chairman — R. W. Fitzgerald, Sup't. of Filtration, Norfolk, Va.

Vice-Chairman — Roland J. Leveque, Sup't. of Filtration, Fredericksburg, Va.

Secretary — Norman J. Phillips, State Dep't. of Health, Richmond, Va.

Treasurer—E. C. Meredith, State Dep't. of Health, Richmond, Va.

Trustees—City Eng'r., W. G. Meyers (Harrisonburg, Va.); Sup't., L. J. Stockner (Galax, Va.).

(The Virginia member on the A.W.W.A. Board of Directors is R. C. Bardwell, Water Supply Eng'r. of the C. & O. Ry. System.)

Secretary Snidow Retires

In placing the names in nomination, Chairman Taylor announced that H. W. Snidow, who had served as Secretary for 10 years, now found it necessary on account of the increasing duties in connection with his State Department of Health work to ask to be relieved. However, said Mr. Taylor, the Section was to continue to benefit by Mr. Snidow's experience and guidance, since the young man proposed as the new secretary would be closely associated with the past-secretary in the State Dep't. of Health offices.

President Howard's Talk

Virginians felt honored over the special trip by plane made from Toronto to Charlottesville by Norman J. Howard, President of A.W.W.A.

Mr. Howard after commenting on the prowess of A.W.W.A., now 4,000 members strong, and the several activities being pushed to completion under Secretary Jordan's vigorous management and leadership, swung onto the question of "home protection" as it applies to water works properties in these troublesome days, and in what may be ahead for this country as well as Canada.

In addition to such fundamental considerations as auxiliary supply, arterial mains, mobile repair units and sterilization equipment, and pumping equipment, he stressed the need for positively safeguarding valuable records and maps of water works structures. These records, so necessary in replacements, he suggested should not be stored in any single place. Duplicates should be available and stored in safe places if possible serious embarrassment incident to their loss was to be precluded.

Concerning the 1941 Annual Convention scheduled for Toronto, President Howard said that this convention would go forward as planned. That Canada would be found especially interesting under war time conditions and that there was no obstacle to travel from the U. S. into Canada or through Canada. His closing statement was that Canadians were as confident as ever of ultimate, if long fought out, victory—(Vigorous Applause). A few minutes later Mr. Howard was on a Canadian bound plane for home.

Technical Sessions

(Chairman Wm. G. Myers, Presiding)

The meeting was opened with a talk by H. E. Jordan, Executive Secretary of A.W.W.A., which constituted a review of the "Highlights of the 1940 Annual Convention of A.W.W.A., in which he emphasized the packed session devoted to taste and odor correction, with particular interest being manifested in results

from super-chlorination controlled by the break-point method, which has come to be termed "break point chlorination." Then he emphasized the splendid work of the Committee on Steel Pipe and Coatings, and the rapid progress made by the Committee on Meters; the prowess of the Financing and Accounting Division, its potential value and possibility of growing like the Purification Division had. Mr. Jordan said that the new Hydrant Specifications of A.W.W.A. have just been published in the Journal and that Tank Specifications are ready. Meter Specifications, in the initial draft, are coming along rapidly for early release. Mr. Jordan then stressed the part that the 25 Sections of the Association can take in establishing sectional committees to study and report on various subjects, and urged the Virginia Section to do something in this direction in order to establish definite aims and objectives — particularly in reference to matters of concern to water works men in the territory served. He cited the Information Exchange conceived and so helpfully developed in the Canadian Section for benefit of its members.

Norman Phillips, New Secretary
H. W. Suidow, Past Secretary
(Retires after 10 year service.)

E. C. Meredith, Treasurer
(All being Ass't. Engineers in the State Department of Health.)

(Later in the meeting the Virginians voted to set up such committees—one in particular being a Committee on Records, Accounting and Valuation, and another committee is to study the specific needs of the Section for the purpose of recommending future activities.—Ed.)

"Some Problems of a Small Water Works Operator" by E. R. SHARP, Asst. County Eng'r., Henrico Co., Richmond, Va.

The three county distribution systems which come under Mr. Sharp are pretty well spread out over territory so sparsely settled as to result in a very sluggish main flow, with many complaints coming in summer due to water degradation in the mains. However, another trouble descended on him like a ton of bricks, after painting a 200,000 gal. elevated tank. A linseed oil like odor or taste lasted two weeks, even though the best painting practice had assumedly been followed. After this had been cleared by emptying the tank and main flushing, the "black-water" season was on him. This "black-water" presumedly comes as the result of sulphate breakdown into hydrogen sulphide. In turn the sulphide changes otherwise "red-water" into "black-water" identified as containing sulphides of iron. So far the only remedy, in the warm season of this trouble, is that of hydrant flushing almost continuously. Thereby, is created a sizeable waste of water just in order to keep fresher water passing through the system. In one system the waste in flushing actually amounts to more than the metered consumption. Attempts to maintain residual chlorine in the systems had proved a seeming impossibility in this instance. In the two other systems flushing waste amounts to 7% and 9.7% of the water pumped. His chief trouble was, therefore, not in producing good water but in "good water maintenance."

Vice-Chairman
Roland LeVeque
Sup't. Filtration
Fredericksburg

National Director
R. C. Bardwell
Sup't. Water
C. & O. Ry.
Richmond

In handling complaints of high meter readings and bills, Mr. Sharp had found the records made by attaching a "Meter Master" to the customer's meter very helpful, just as had Mr. Taylor in Roanoke, and others. However, some customers are never satisfied until the meter is changed.

Another method pursued with dissatisfied customers is to draw 15 gals. of water in the presence of the complainant and let him see the dial hand move just the two divisions representing 2 cu.ft. or 15 gals.

In the discussion, it was later pointed out by another operator that the "Meter Master" record was a fine thing on the customer's premises, but actual testing of meters on the premises was a procedure not without hazard. Instead, the policy should be to make a shop-test, but only provided the customer agrees to be on hand during the test. If on the premises there happened to be a hidden leak of consequence when the 15 gallons was drawn, the dial would naturally show more than the amount drawn and the customer would be convinced then that the meter was fast without question. Shop test or none should be the policy, according to D. R. Taylor of the Roanoke Water Department.

R. C. Bardwell, in confirming Mr. Sharp's opinion of sluggish main-flow being responsible for water degradation, reported a case in which replacement of a run of 2 in. pipe with ½ in. pipe cleared up a "red-water" complaint.

Linn H. Enslow said that a similar difficulty to that on the Henrico Co. systems had been materially improved by aerating the deep well supply and chloramination to check bacterial activity under the high temperature and sluggish flow conditions. Ordinarily dissolved oxygen in mains would be considered to aggravate corrosion but in this instance the oxygen was necessary to keep the bacteria, found in the slime on the pipe walls, from going after oxygen in the sulphates and releasing the byproduct hydrogen sulphide ($SO_4 + H_2O = H_2S +$ Oxygen). Indicative that the trouble was of biological origin was the fact that in cold weather "black-water" is not produced. A combination of aeration and chlorine-ammonia treatment seemed likely to prove the most practical solution and reduce flushing waste materially.

"Super Chlorination and De-chlorination" by M. C. SMITH, Chief Engr., and H. E. LORDLEY, Filter Plant Sup't., Department of Utilities, Richmond, Va.

The paper by Messrs. Smith and Lordley recited experiences with superchlorination of raw water at the Richmond filter plant, followed by dechlorination to a fixed residual at the filters with sulphur dioxide. The reason for the partial dechlorination step was explained as due to the fact that advantages of maintaining a residual through the long period coagulation and clarifying basins had proved many. On the other hand, to carry too much residual onto the filters (and through them at times) created another taste problem. Now, the practice is to insure at all times an adequate pre-chlorine dosage to insure a residual well above 0.2 p.p.m. at the basin outlet, regardless of cloudy or sunny days and their effects on the speed of chlorine dissipation dechlorinate to a fixed residual

value at the filters, thus maintaining a constant condition and assurance that there will be no taste production through the filters. The process had proved exceedingly simple of control without SO_2 control equipment other than a pressure reducing valve with needle valves beyond. While the chlorine consumption had gone up as a result of this super-safety method of operating, complaints abroad and "headaches" at home had gone down.

Mr. Smith, who presented the paper, pointed out that super-chlorination of raw water at Richmond was far from new. Our notes on this are not clear, but it dated back to 1935, if not earlier, as reported in a paper published in the Oct. 1936 issue of the A.W.W.A. Journal. Pre-chlorination had originally been applied on the recommendation to L. H. Enslow as an aid in coagulation. In this procedure it had soon been learned that a degree of super-chlorination was essential if tastes were not to be produced and coagulation basin performance was to be at its best. The practice developed was that of maintaining not less than a defined *minimum* excess (residual) chlorine, with little concern as to the *maximum* if the desired effects were to be secured. As of today this practice can be termed super-chlorination to a point *beyond* the "break-point" at all times, although the so-called "break-point" had not been identified at the time and is frequently now very indistinct at Richmond, if observed at all. We have learned that we do not have to detect the "break-point" to get results at Richmond, and apparently we stayed in a zone well above it without realizing that there was such a thing, said Mr. Smith.

In considering a study of super-chlorination, Mr. Smith directed particular attention to the excellent bulletin—"A Laboratory Method for the Study of Superchlorination"—recently issued by The Chlorine Institute. (A copy may be had by addressing The Chlorine Institute, at 50 East 41st St., New York, N. Y.—Ed.)

Mr. Smith called attention to the fact that although at times prechlorination had doubled to tripled the threshold odor in the raw water, by the time the reactions had been completed in the basins not one bit more carbon had been required in the treatment applied at the filters, and only to a very moderate degree at this point.

From Two Dominions—(The Old and the New)

Richard Messer, Chief Eng'r. Dep't. of Health of the Old Dominion

Norman J. Howard, Director of Purification, Toronto in the New Dominion (President of A.W.W.A.)

The practice most recently developed at Richmond is that of reducing the residual chlorine at the basin outlet to between 0.2 and 0.4 p.p.m. atop the filters. In this 0.9 parts of SO_2 are required to neutralize each part of chlorine removed. In summer 0.4 to 0.5 residual is maintained to hold the filter beds more sterile during the long runs of 100 to 300 hours. Something of the effects of cloudy vs. sunny days (and to some extent changes in water quality) on the chlorine residual, left to be removed at the filters, may best be pictured in the following relative quantities of the two chemicals recorded as monthly averages:

Pre-Chlorine	*SO_2*
42.3 #/mg.	1 #/mg.
35.2 "	2.2 "

This very variation is the best possible picture as to why the practice is justified in making for "safe" and dependable operation, without hazarding production of tastes due to excess chlorine on cloudy days.

Mr. Smith, pointing out that the savings in several directions had more than paid the added cost of super-prechlorination, stated with emphasis that it was his opinion when considering benefits such as improved pretreatment, stabilized settling basins, pleasingly clean sand beds, exact control of chlorine residual with complete sterilization assured, and reduced tastes and odors as the probable reward, every operator should at least investigate super and de-chlorination.

"The Adaptation of Hexametaphosphate for Corrosion Control and Prevention of Scale Formation" by R. C. BARDWELL, Sup't. of Water Supplies, C. & O. Railway Co., Richmond, Va.

Terming sodium hexametaphosphate ($Na\ PO_3)_6$ the most interesting chemical ever dealt with in his experiences in water treatment, Mr. Bardwell explained reasons why on the C. & O. Ry. System 70,000 to 100,000 lbs. of the material is used yearly. The compound had first been used 3 years ago in hot water lines to check scale deposition—at the same time the 4 p.p.m. dosage employed unexpectedly removed scale already deposited in these lines and valves within 30 days. After that the dosage

Programmers

R. C. Clements, Distr. Mg'r. W. & T. Co., Washington

E. R. Sharp, Ass't. County Engr. Henrico Co., Richmond

Reeves Newsom, Consulting Eng'r. New York, N. Y. (Past-President of A.W.W.A.)

Here and There on Virginia's Campus

(1) A glimpse of the swanky "dorms" wherein members and guests were quartered; (2) Just a little "business session" on the outside in which "Doc" Taylor (Roanoke's Sup't.) was busy taking some notes when we happened along; (3) From Harrisburg, Pa., came Mike Glace, Secy.-Treas. of the Penna. Water Operators Ass'n., and Chairman of A.W.W.A.'s Four States Section, to see how the Virginians were doing—with him came Mrs. G., her sister and daughter; (4) Proving that "The Sun Shines Nowhere Quite So Brightly as in Ole Virginny"; from the left in this smiling group is Richmond's Lordley, Newport News' Pharr and Spivey (right rear) and "Nuchar's" Bob. Haywood—who knows how to take good color movies; (5) One of the interesting serpentine walls which Mr. Jefferson had built around the original campus. The serpentine designed permitted construction with a single course of brick, which in those days were imported from England. Most of the original walls are ivy covered but this particular section, photographed to show the serpentine effect, had been recently rebuilt.

In and Out of the Class Room

(1) "Jo" Millikan, Roanoke's Chemist, and Neptune's Mike Siebert of Richmond; (2) In this dormatory group nearest the camera are Town Mgr. R. L. Blankenship of Orange, Va., and his Plant Sup't. W. E. Knighten; (3) Prof. W. M. McGill, Va. Geol. Survey, lecturing on "Deep and Shallow Wells"; (4) Must be Marsden Smith's bid—around the table from the dealer (Sigworth) are Lordley, Smith, and Glace. Looker-oners are Dick Ford and President Norman Howard. (5) In "Class" again, Jeff. Corydon is giving the fine points of Proportioneer's latest—the "See-Thru" plastic head solution feeder. (6) L. J. Stockner, Sup't. of Water, Galax, Va., and his neighbor "Bert" Harton, Sup't., Hillsville Water Co.

was dropped to 2 p.p.m. to hold the carbonate of lime in solution and thereby prevent further scaling up of hot water lines. Subsequently the effectiveness of this same chemical in suppressing corrosion and precipitation of iron ("red-water") had been observed.

In the cold water lines the treatment to stop scaling had not been effective in removing old scale, and mechanical pipe cleaning had to be resorted to. However, observed Mr. Bardwell, the treatment had been effective in softening the scale and thereby proved helpful in the mechanical cleaning later applied. Then an important attribute of Calgon treated water had been observed in the multi-tubed feed-water heaters on locomotives which have not had to be acid cleaned since. Such formerly was required at 15 day intervals, requiring a lay-up of the locomotive and labor expense. He also cited other advantages accruing in locomotive maintenance. Then Mr. Bardwell staged a demonstration with Calgon to show its effectiveness as a precipitation preventative. In another building on the campus a demonstration of the effectiveness of Calgon in suppressing corrosion was made. This was about the same scheme as has been shown at the A.W.W.A. and New England Conventions to prove that water treated with 1 p.p.m. or even less, will not rust steel wool through which it passes continuously. Mr. Bardwell commented that hardly any other treatment at a cost so nominal as $1.60 per million would do as much for the average water system.

Owen Rice, Development & Research Chemist, Hall Laboratories, Pittsburgh, Pa., presented the most likely theory to account for the effects of hexametaphosphate treatment, and referred to the studies made at the University of Arizona which had brought conclusions to the effect that crystals in their very first stages of development in the precipitation effect

H. E. Lordley
Sup't. of Filtration
Richmond

Mrs. C. R. Nuckolls
President and Owner
Hillsville Water Co.

are stopped from further growth by the phosphate adsorbed on the crystal faces. In regard to corrosion, there seemed to be a plating out or film effect on the metal surface. To prevent precipitation of iron, a dosage of Calgon equal to the quantity of iron present was required. For corrosion control less is required, 0.5 p.p.m. being effective in most instances after a period of continuous application. At present 60 water plants are using Calgon for corrosion suppression; 2 municipal and 6 industrial plants using it to prevent iron discoloration due to precipitation, "red-water" being one form of such precipitation. In some instances, lime is continued along with the use of hexametaphosphate, but waters as low as pH 5 do not require lime when the phosphate treatment is effectively applied.

"Property Records and Valuation"
by REEVES NEWSOM, Consulting Engineer, New York, N. Y.

Mr. Newsom, a past-president of A.W.W.A., came up from Newport News where his firm has just been making a detailed study leading to betterments to the system to allow the increased loading placed on the plant as an outgrowth of the rearmament program. In his very pointed paper, dealing with the paucity of dependable records in municipal plants as a rule, Mr. Newsom threw the "spot-light" on what the lack of such records frequently cost water utilities when faced with important immediate questions as to going worth of the system, in making fair rate schedules or in physically strengthening the system to provide added service—within or without the corporate limits.

Also in taking a look beyond the present horizons in municipal utility practices, Mr. Newsom pointed to the rapidly changing category of municipal plants in respect to methods of financing and in respect to the trends toward regulation by Public Service Commissions. Notably had this already been true in Maine, Wisconsin, Indiana, West Virginia and just recently control over rates outside of corporate limits was given the Pennsylvania Commission. In a similar respect the Province of Ontario controls rates, and just now is preparing evidence for an application by the City of Ottawa to advance suburban rates on the basis of true costs plus a reasonable profit.

The newer methods of financing public utilities by revenue bond sales

(1) Tom Spivey, Chemist and Jim Pharr, Sup't. Filtration, Newport News, Va. (2) Henry Salomon, Norit Co. (New York) and Burt. Graham, Activated Alum Corpn., Balto. (3) H. H. McCanna, Town Mg'r., Crewe, Va., and Seth. Burnley, City Mg'r., Charlottesville. (4) "Smoke" Clements of W. & T. Co. displays the "World's Smallest Chlorinator"—(described in his talk). (5) Augusta County Sanitary Engineers, T. L. Anderson (Waynesboro) and C. O. Barnes (Staunton).

(without involving taxation increase) was one reason for increasing jurisdiction by Public Service regulatory bodies and requirements of accurate records and record keeping in arriving at and maintaining proper equities — namely, in protecting bond holders.

At some length, Mr. Newsom then discussed methods and ways of evaluating water works properties which are usually broken down into 9 divisions—Land, Structures, Purification Equipment, Transmission and Distribution Mains and Accessories, Services, Meters, Hydrate, General Equipment. In commenting on valuation of mains (frequently comprising 80% of the gross worth of the system) Mr. Newsom said that cast-iron mains had been, as a rule, depreciated too severely. He cited records to prove this contention in cases where thorough records were available. For instance, in Springfield, Mass., survival of C.I. pipes after 75 years service is practically 90% for the 6 and 8 in. sizes and better than 93% for the 10 in. pipes and larger.

In summary he stated that: "Methods of operation that have been followed in the past, even in as relatively stable an industry as the water supply business, are undoubtedly becoming outmoded by the changes which are taking place in the world today. It can be anticipated that new demands will have to be met for justification of many of the things that in the past have been done as a matter of course. The raising of funds for water extensions is already in a different category psychologically than before the days of PWA. The scope of activity of regulatory bodies of all sorts has been vastly enlarged. Rates and the allocation of charges between domestic and fire service can be expected to be questioned even in municipal plants, in this era of high taxes in prospect. Almost certainly some degree of change for water departments may be expected and conceivably it can go beyond anything we now anticipate.

Whether it be an effort to combat undesirable changes or one to take the greatest advantage of desirable ones, the waterworks plants which will be most successful will be those that can prove their contentions by recorded facts and not merely by the recitations of mental precedents.

Lynchburg's C.I. Pipers

John D. Capron (President) Glamorgan Foundry — *Arthur Roberts, Jr. (Chief Engineer) Lynchburg Foundry*

While most of the points regarding good records have been related to valuation, there are, of course, others which may be equally important. Not the least is the fact that the keeping of good records insures better operating knowledge and tends to produce more careful attention to supervision.

Good records form the best basis for intelligent future planning and for decisions as to the type of materials and equipment giving the best service under local conditions.

The accumulation and compilation of adequate records of what you have, and what has happened to what you did have, should begin today. It is going to be difficult at best, but you are urged to make a start and that promptly."

E. F. Dugger, Manager, Newport News Water Works, (a past-president of A.W.W.A.) in complimenting Mr. Newsom on his vision as a former head of 40 water supply properties, suggested the appointment of a committee to study unification in record keeping, to meet the coming needs outlined. (By resolution passed, such a committee is to be appointed, as earlier recounted in this report.—Ed.)

"The New Law of Design for Cast Iron Pipes" by JOHN D. CAPRON, President, Glamorgan Foundry Co., Lynchburg, Va.

Mr. Capron's paper was something of a review of the development of specifications and formulae used in deriving the new specifications of the American Standards Association which have become official standards for the American and New England Water Works Association and the American Gas Association, after 13 years of study and work. It is not possible in this type of digest to properly present the discussion of factors and formulae evolved by Mr. Capron.

In regard to pipe laying practices, external trench loading was considered of importance almost equal to internal pressure. With less than a 5 ft. cover truck wheel loading was found the dominating influence. Regarding deeper pipes water hammer attained first importance. The factor of safety applied in the new design has been 2½ times the combination of simultaneous internal bursting pressure and external loadings. As to the support of pipe in trenches, the practice of blocking 6 in. pipes puts 6 times the strain on the pipe of that from a flat trench bottom with effective tamping around the pipe. It was the committee's conclusion that this last method should become standard practice for distribution systems and all smaller sized pipe. For the larger pipes a shaped trench bottom and tamped back fill to above the crown of the pipe should constitute standard practice.

"Application of the New C. I. Pipe Specifications" by ARTHUR ROBERTS, JR., Chief Engineer, Lynchburg Foundry Co., Lynchburg, Va.

We shall not even attempt to cover Mr. Roberts step by step process of applying the several critical formulae in hypothetical problems involving selection of pipes in specific applications. We doubt that more than 2½% of Mr. Roberts' audience could follow his scholarly analysis and application

(1) E. F. (Gene) Dugger, Mg'r. Newport News Water Works, Jack Capron, Pres., Glamorgan Fd'y. Co. and Reeves Newsom, Cons. Engr. of New York City (user, maker, prescriber of C.I. pipes); (2) A pretty Irish setter and the three others (all from the Bluefield (Va.) Water Dept.) are Filter Sup't. B. C. Noel, Foreman E. C. Harmon and Water-Man, C. B. Belcher. (3) L. J. Stockner, Sup't. of Water, Galax, Va., and Mrs. Stockner (Mrs. S. was elected a trustee); (4) Another group enjoying the Virginia sunshine, which hasn't been too plentiful this season. (5) A. B. Wigley of the Bird Laboratory Supply Co., F. O. Baldwin, Chief Chemist, Richmond, Va., and "Rolly" LeVeque, Sup't. of Filtration, Fredericksburg.

(1) *C. F. Otey, Chief Operator and Geo. R. Elder, Sup't. of Utilities, Radford, Va.* (2) *Jerry Kavanagh, W. & T. Co., Roanoke, Va., and W. F. Johnson, of Wiley and Wilson, Engrs., Lynchburg, Va.* (3) *The President of the Hillsville Water Co.—Mrs. Carrie R. Nuckolls and Mrs. Lillian Semons, Secretary.* (4) *"Dick" Kirchner, of Mueller Co., and "Ed." Canton of Badger Meter Co.* (5) *Eddie Ruehl, Field Rep., Va. League of Municipalities (former Sup't. of Water at Bluefield, Va.) and Frank Taylor, of Pittsburgh Equitable Meter Co.*

of equations and factors in such application. However, we did gather that the net result of it all was a much more economical pipe in tonnage per mile, as a result of the scientifically developed formulae and the new specifications. He stressed the fact that this much had already been amply demonstrated on important projects. To him it seemed axiomatic that if the standards were to be met by one material, such as the predominantly employed cast-iron pipes, that other pipes should be expected to meet the same standard requirements in the way of test applications and safety factors applied.

The Problem Hour

Under Major Richard Messer, Chief Engineer, Va. State Dep't. of Health, the closing afternoon session was devoted to maintenance and operating problems in several 15 minute talks.

"The Electrical Protection of Elevated Storage Tanks" by H. E. Silcox, Engineer, C. & O. Railway Co., Richmond, Va.

Mr. Silcox in a brief illustrated talk discussed the principles involved in Cathodic protection of steel tanks and standpipes such as had been recently giving a splendid account of itself on the C. & O. System. (This topic has so frequently been covered in recent issues, and is so thoroughly described under "Corrosion Control" in the Reference and Data Section of W.W.& S., for April, 1940, that it will not be repeated here. If a reader wishes further information and will so advise us we will see that he gets it.—Ed.)

"What Is Meant by Back Syphonage?"—was explained with the aid of colored blackboard sketches by *R. T. Homewood,* State Department of Health Engineer. In his lecture the speaker pictured the more common hazards in toilet fixtures, yard hydrants with drainage holes at the base, etc. He stated that installation of syphon breakers was perhaps the simplest expedient and least costly remedy.

H. E. Lordley, (Richmond) remarked that yard hydrants were very definitely the source of worms in more than one bucket of water drawn from such socalled frost proof hydrants. Complaints of worms in the water, upon investigation had proved to be real.

"Deep and Shallow Wells" were discussed by *Wm. M. McGill,* Engineer, Va. Geological Survey, Charlottesville, Va., who pointed out what

Past-Chairmen
S. L. Williamson, City Eng'r. (Charlottesville)
H. A. Johnson, Sup't. Filtration (Danville)
E. C. Meisel, Town Mg'r. (Williamsburg)

constituted good and bad well casing practice. In 80% of well pollution cases traced, it was found that improper or defective casings was the source of the trouble. He stated that the Survey was ready to assist any community in the matter of determining the probable ground water yield and expected quality, and in selecting locations best suited for putting down wells. He referred to four bulletins pertaining to ground water supplies and well construction and development available from the State Geological Survey.

In reply to a question as to how a well 785 ft. deep, with 8 in. casing, could be enlarged, Mr. McGill stated that doubling the diameter usually yielded 15 to 30% greater volume at a given draw down. However, it would probably be more practical and effective to put a twin-well down 20 ft. distant, from the present well.

"Feeding Small Amounts of Chlorine and Other Chemicals" by R. C. Clements, Wallace and Tiernan Co., Washington, D. C.

Mr. Clements stated that the smallest supplies being chlorinated run 1 gal./min., in which case 1 lb. of chlorine would be fed over an 166 day period at the rate of 0.006 lbs. per day. For supplies of 1 to 10 g.p.m. the following schemes were in use for applying chemicals:

(1) Orifice Boxes—subject to cloggage and stoppage.
(2) Solution Pressure Pots—lacking in uniformity of feed or visibility of feed or chemical charge. Possibility of their construction from transparent plastic was mentioned.
(3) Electrolytic Cell — for chlorine (hypochlorite) production from salt solution at a cost of 10 cents per pound for chlorine equivalent produced.
(4) The Diaphragm Pump Type Feeder—has the advantage of injection against pressures; automatic proportioning or start and stop operation; electric, gasoline or water motor drive; flexibility of operation; and simplicity.

Mr. Clements then exhibited what he said was the smallest "Chlorinator in the World." It turned out to be a cone suspended from a wire. The cone consists of plaster of paris impregnated with azo-chloramid. It is intended to be suspended in the well, tank cistern, etc., and capable of treating 500 gals. with 4 p.p.m. chlorine equivalent. The advantage of azo-chloramid is that it does not taste in concentrations up to 10 p.p.m. available chlorine.

Jeff Corydon, President, %Proportioneers Inc.%, Providence, R. I., substituted for Alan Wood of Philadelphia as discussor. He agreed with all that Mr. Clements said concerning the diaphragm type pump and then explained and exhibited the .newest %Proportioneers'% development — the "See - Thru" Chlor-O-Feeder which is constructed of colorless transparent plastic, so that the operator is enabled to see the "wheels go round" when this feeder is in opera-

(1) R. F. Whittaker, Sup't. of Water, Emporia, Va.; (2) H. L. Pippin, Engineer of Water, Bristol, Va.; (3) R. L. Blankenship, Town Mg'r., Orange, Va.; (4) J. C. Mann, Sup't. of Water, St. Paul, Va.; (5) J. P. Millikin, Chemist, Roanoke Water Dep't.

tion. The idea originated after the advantages of the transparent plastic sight-finder on Chlor-O-Feeder had earlier been demonstrated and proven.

Asked if damage to the plastic parts would prove likely from dropping a wrench on them, Mr. Corydon proceeded to demonstrate by throwing a part on the concrete floor with force sufficient to cause it to bounce high in the air.

"The Selection of Meters for Services" proved to be the most interesting topic of the entire session. It was introduced and discussed by *D. R. Taylor,* Plant Sup't., Roanoke, Va.

Mr. Taylor said that to prescribe the most nearly correct size of meter for a given or proposed service, was only possible after the service is placed in use and a consumption record can be had by placing a "Meter Master" on a meter in use, or a recording meter on the service. In respect to developing meter records, for the purpose of showing customers, it was in his opinion unfortunate that the record had to be in terms of cubic feet rather than gallons, since the customer could understand gallons and quarts but hardly ever cubic feet. He had, therefore, conceived the idea of inserting a 1. to 7.5 conversion gear in the "Meter Master" cable which would then record gallons on the regular charts of the "Meter Master." Two such converting gears had been produced for his use by the manufacturer at a cost of $17.50 each and were now in use.

Through use of the recording meter and "Meter Masters" many interesting things had been learned relative to water use habits and requirements not suspected. In the first check the 24 hour chart is used and then for refinements the 6 hour charts are employed later. In citing some interesting cases, Mr. Taylor checked a line supplying 53 residences, three of which cost $90,000 each or more. The record revealed these astounding figures for the 53 homes. The maximum draft was 12.2 g.p.m. only; the minimum use 1.66 g.p.m. Strange as it sounds, a 1¼" meter proves ample for this extension. The "Meter Master" record serves as a leakage survey, when considering the minimum flows recorded.

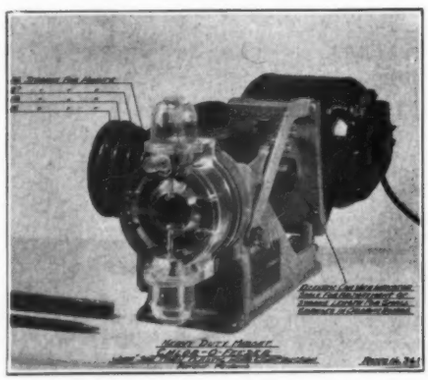
Into a section supplying 460 homes, a 2 in. meter proves ample for the maximum of 71 g.p.m. to the minimum of 12½ g.p.m. and average of 47 g.p.m.

A community of 4,000 required 120 g.p.m. maximum.

A building (165 offices) required 30 g.p.m. maximum in Winter; (with air conditioning load), 60 g.p.m. maximum in Summer.

A hospital (110 beds) required 25 g.p.m. maximum.

As an example of the value of meter checking and change, Mr. Taylor told of a 3 in. velocity type meter in an office building, which the "Meter Master" checked at 66 g.p.m. average day flow and 1 g.p.m. night flow. A test disc-meter was hooked in series and revealed a 71% accuracy during day flows and 23% accuracy during the night. A computed loss was at the rate of $183 revenue annually. The customer insisting on fire flow, the solution was to install a fire line meter and around it a jumper line and ⅝" meter.



Proportioneer's Newest

Midget Feeder With a Visible "Heart Beat"—Made Possible by the "See-Thru" Plastic Head. (Was Unveiled at the Virginia Meeting.)

Another instance involved a 4" compound in an office building. The checking record showed that for other than fire service a 1" meter was sufficient for the 38 g.p.m. average and essentially so for the maximum. Here the difficulty was that the average flow was at the change-over point of the meter, resulting in a barely cracked swing valve and a 92% registration only. After some study, instead of a replacement a jumper was run around the meter and a 1" meter installed therein, and valve set to bleed 18 g.p.m. through the jumper. Thus with 18 g.p.m. through the jumper, 20 g.p.m. making up the average flow of 38 g.p.m. passed through the small side of the compound. In summer when the demand for air conditioning is on, the jumper line is closed off and the large side of the compound goes into full flow action. At a cost of $20.00 revenue increase mounted $85.00 for the year.

Mr. Taylor also revealed a chart prepared to determine the minimum size tap to make for a service line of given length, and thus avoid needlessly large tappings and corporation cocks.

Mr. Taylor revealed that the newest field test meter used on the system is constructed of silicon-aluminum alloy for lightness, and is always used with calibrated orifices and manometers employing mercury or carbon tetrachloride.

In reply to a question, Mr. Taylor stated that compound meters are never installed under 3 inch size. Compounds required yearly servicing whereas 2 in. disc meters can be relied upon for two years at least. For fire service meters 10 years of experience had led to favoring the plain type fire service meter. The customer does not pay for the meter but pays all setting costs and $8.00 monthly service charge.

Reeves Newsom stated that his experience in operating 40 company owned properties checked with Taylor's as to using no compound meters under 3 inch size.

Mr. Taylor closed by telling of another type of metering—that of annual pump checking with the Simplex Pitot Tube outfit and their policy regarding changing impellers to maintain maximum pump efficiencies—a real revenue saving practice.

With a vote of thanks to "Doc" Taylor for his thorough and interesting "diagnosis" of Meter Troubles—th 7th Annual Meeting passed into history.

"PREPARING FOR MARKET" A CURRIER AND IVES PRINT

YESTERDAY'S STANDARDS WON'T DO

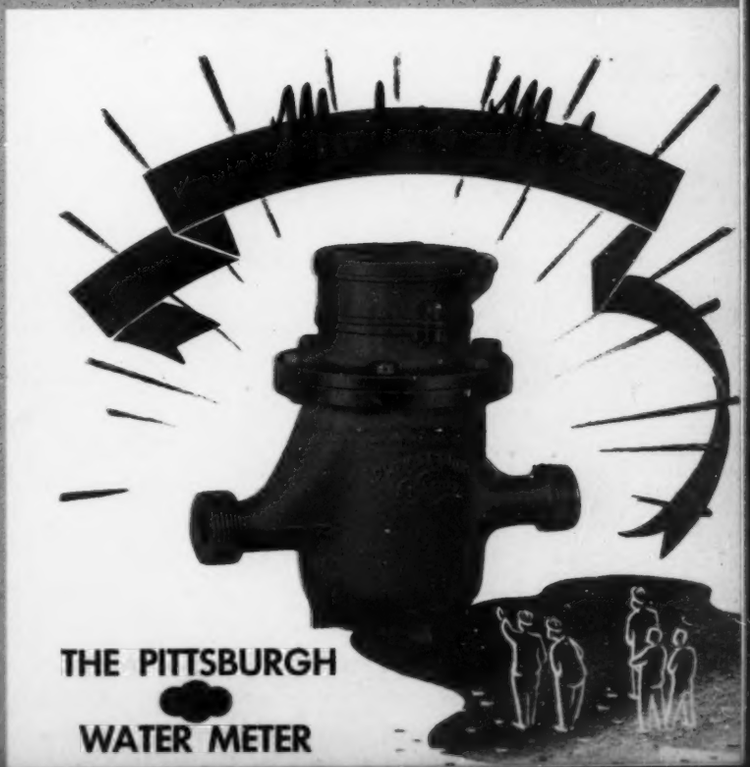
IN WATER METERS EITHER

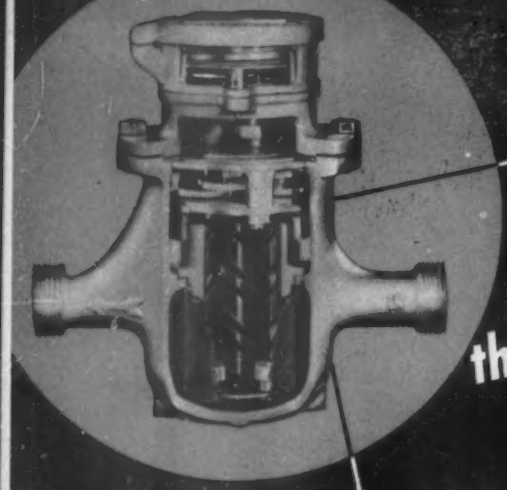
Bustles, barns, back yards and backhouses . . . memories to many, curiosities to a majority of the present generation growing up in this fast changing, ever improving world. For man's ingenuity is constantly at work, eternally challenged by outmoded, outdated practices and methods that cry for change in order to make our lives more pleasant and productive.

Take the water meter as an example. The basic patents on the disc type meter date back to the early eighties. Modern machine tools, improved methods and better materials make today's disc meters vastly superior to those of 50 years ago. However, these alone cannot improve a basic design having inherent weaknesses which have long been recognized by waterworks men and manufacturers alike.

Disc meters will not measure the low flows with a sufficient degree of accuracy; they wear rapidly and become noisy; they are expensive to maintain. Until the Pittsburgh Equitable Meter Company had the courage and foresight to produce the IMO meter, which set new standards of performance, there was little criterion by which meter quality could be judged. It took an entirely new type of meter to provide measurement standards in keeping with today's needs.

A copy of the above Currier & Ives print, "PREPARING FOR MARKET", —without advertising and suitable for framing—may be secured by writing to the Pittsburgh Equitable Meter Co.



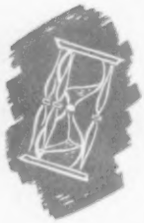


PERFORMANCE STANDARDS go up with the PITTSBURGH IMO METER

OW FLOW ACCURACY

TTSBURGH IMO METERS MEASURE THE W FLOWS that either escape measure- ent entirely or are only partially corded by conventional meters. ctory specifications guarantee accu- cy of 98% at 1/4 g. p. m.; 90% at '12 g. p. m.; the most stringent accu- cy test ever applied to new meters.

USTAINED ACCURACY



IE INITIAL ACCURACY OF PITTSBURGH IO METERS IS SUSTAINED ACCURACY. umerous tests show that even after veral million gallons have been easured, Pittsburgh IMO Meters easure slightly better on the low ows than when first put into service id that their accuracy does not hange at rates of flow above 1 g.p.m.

ILENT OPERATION

HE BASIC CONSTRUCTION OF THE PITTS- URGH IMO is responsible for its quiet peration. Smoothly turning rotors, recision cut to mesh perfectly, re- olve with a semi-floating action as ie water flows through the measur- ig chamber in a straight line. For his reason the IMO can never become oisy; there can be no clicking sound annoy your consumers.

OW MAINTENANCE COST

TTSBURGH IMO METERS COST LESS TO AINTAIN. The unique design of the easuring chamber and its semi- oating rotors increases the life of the orking parts as compared to conven- onal meters and insures longer ouble-free service.

Remember—PITTSBURGH METERS

WEAR IN WHERE OTHERS WEAR OUT

THO IN U. S. A.

In the Pittsburgh IMO, an entirely new type of design results not only in performance which is impossible to duplicate with any other type of meter, but also in sustained accuracy and silent operation which years of service will not affect. The accuracy of conventional disc water meters is almost entirely dependent upon the closeness of clearances within the measuring chamber. However, the difference between the coefficient of expansion for bronze and hard rubber will often cause a closely fitted disc meter to stick or to wear more rapidly than a disc meter fitted with greater tolerances. Nevertheless, it is entirely possible to build disc meters with excellent accuracy characteristics—*when new*. The real test of any meter is how well it performs after it has been in service for a period of years. It is here that the weakness in disc meter design reveals itself, for wear on the working parts lessens the accuracy in an ever-increasing ratio as the meter remains in service.

The sustained accuracy of Pittsburgh IMO Meters has been conclusively proved by hundreds of durability tests conducted by waterworks departments on their own lines, using their own proving equipment. The following quotation, which speaks for itself, is taken from a letter in our files: "We installed one of these meters on a durability test, placing it on a Turbine Cooling Line. This meter was installed August 16th, 1938 and up to the present date (April 5th, 1940) it has passed 1,606,528 cubic feet of water. It has operated at a rate as high as 4958 cubic feet per day. The meter was brought in for test as of the present date and found to be registering 90% at a rate of ¼ G.P.M.; and 100% on a stream of ½ G.P.M. up to its rated capacity."

The test on this meter after it had measured the equivalent of over 12,000,000 gallons, while not up to new IMO meter standards, nevertheless equalled the present standard accuracy specifications of the American Water Works Association for new disc meters.

One of the most pleasing features of the Pittsburgh IMO Meter is its silent operation. Many well known waterworks executives say this silent operation alone would justify the use of the IMO even if it were otherwise no better than ordinary meters. An annoyed consumer is never a satisfied one. With the increasing attention being devoted to better public relations, the elimination of noisy water meters should be given careful consideration by waterworks men.

The Pittsburgh IMO Meter cannot become noisy, because smooth turning rotors, precision-cut to mesh perfectly, replace noisy slapping discs. The rotors revolve with a semi-floating action and water flows through the measuring chamber in a straight line without any turbulence. Wear on rotors or measuring chamber has been shown to be negligible. The basic construction precludes the possibility of the IMO meter ever disturbing the sleep of the householder.

PITTSBURGH EQUITABLE METER COMPANY

MERCO NORDSTROM VALVE CO.

NEW YORK · BUFFALO · PHILADELPHIA · KANSAS CITY · TULSA · LOS ANGELES — *Main Offices* - PITTSBURGH, PA. — DES MOINES · CHICAGO · COLUMBIA · MEMPHIS · OAKLAND · HOUSTON

Thousands of IMO Meters Are Now in Service — Over 1500 Water Works Systems Have Adopted Them

MAINTENANCE OF SEWAGE PUMPING STATIONS*

By A. L. SODEN
Chief Operator
SEWAGE TREATMENT WORKS
TRENTON, N. J.

THE writer, after some fifteen years of experience with seven pumping stations containing twenty-seven pumps with capacities from 50,000 to 11,000,000 gallons per day, has come to the very definite conclusion that maintenance of this type of equipment involves three main objectives, proper lubrication, cleanliness, and frequent detailed inspection. At first thought the first two involve the last, but dumping oil or grease into a machine plus wiping it off do not constitute inspection any more than feeding and bathing a baby is a substitute for a doctor's periodic checkup. The point I wish to drive home is that good maintenance catches trouble *before it starts* and postpones indefinitely the day when the machine must be scrapped for any other reason than obsolescence.

The use of good oil and grease is a very essential item. Lubricants not suited for each particular piece of equipment may, however, no matter what they cost, do more damage than a cheap oil of a suitable character. It must be kept in mind that too much oil in many cases tends to cause more wear than too little, due to the fact that dust, always present in the air, will mix with the oil and act as an abrasive when passing through the bearings. This situation is more serious in a gravity or pressure feed system than with the oil reservoir type.

It is axiomatic that efficient lubrication is a matter of using good lubricants, properly selected, in the correct quantity, at the right intervals. Neglect or omission of any of these factors means accelerated depreciation and breakdown.

Low Price—High Cost Lubricants

Cheap lubricants are costly in the long run and if the average operator would only sit down and figure the total saving per year in a few cents less per quart of oil, or pound of grease, as against many dollars for new bearings, sleeves and shafting, damaged by cheap "bargain" goods he would realize that the best is none too good. We had an example of this

The Author

in Trenton where for a time the purchasing department paid twenty-seven cents per gallon for automobile oil which was bought on a price basis.

Even though good materials are supplied, one must be certain that they are of the right weight, viscosity, etc., for the job and the only way to be certain is to follow the manufacturer's recommendation for the unit being serviced, or, if this is not available, call in a lubrication engineer from one of the big companies. You will note the word "engineer"—beware of smooth talking salesmen with trick oils that never wear out, made by some magical process and sold at high prices under a fancy name.

It may seem proper to the average person that as long as the correct amount of oil or grease is in a bearing and no noise or heat is noticeable that the machine could run indefinitely. This, however, is *not* true as many pieces of equipment are installed in damp wells where condensation is present, the worst enemy of any bearing no matter what type lubrication is used.

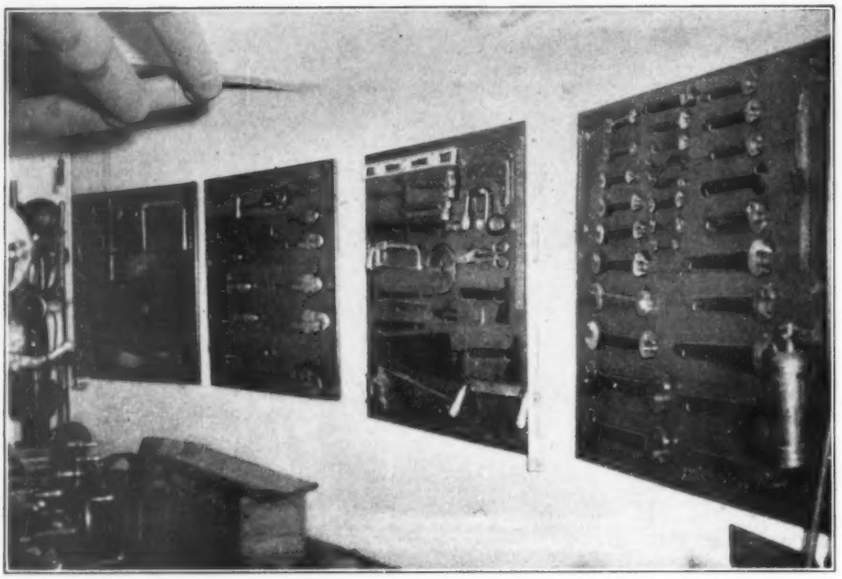
Gravity or pressure feed lubrication systems with an oil filter in the line do not require as much attention as equipment having the oil reservoir. A good method to follow is draining and flushing these types of bearings and refilling with new oil at least every six months, and in some instances where water is present, every three months.

Shaft Bearings

Many line shaft bearings are made for grease lubrication and can be run with safety on equipment in small booster stations for about a year before flushing and repacking with new grease. We have found through past experience that it is sound economy to remove the bearings from the shafts and wash thoroughly in gasoline or kerosene, both the bearings and the oil reservoirs, thus removing all traces of moisture, old grease and foreign matter at least once a year. This procedure should be more frequent in a plant where the equipment

The Main Pumping Station, Trenton Sewage Treatment Works

* Mr. Soden presented this paper before the Silver Anniversary (1940) Meeting of the 25 Year Old New Jersey Sewage Works Association in Trenton, N. J.—Ed.



Shop and Tool Room of the Main Pumping Station—Trenton, N. J.

is running continuously. Care should be taken to put the right amount of grease in a bearing as too much causes bearings to heat through increased friction.

An oil filter, if used, should have at least twice the capacity of the lubricating system. This unit is used to separate the water and oil in a primary chamber and, in a secondary compartment, dirt in the oil which has a tendency to collect in bearing boxes, and any scaling which may develop in the oil lines. Such is particularly true if the latter are constructed of iron or steel pipe and fittings. Copper tubing or brass pipe and fittings are the only materials which should be used, thus preventing damage to bearings due to the stoppage of the oil grooves by pieces of rust or scale which come from iron or steel pipe, even though these be galvanized.

The matter of cleanliness around any machinery is a very important factor not only for looks but for the good of the equipment. It must be kept in mind that next to water, dust and dirt are the most destructive enemies to motors, bearings, controllers, starting switches, and many other pieces of electrical equipment that are found in a pumping station.

Motor Care

Motors must be kept free from water, oil and dirt. A good method of cleaning the interior is with compressed air or a bellows. When using compressed air care must be taken to be certain there is no moisture in the storage tank that could escape through the nozzle used for cleaning. Cleaning motors with compressed air should never be done by an amateur. The older the motor the more brittle the insulation and high pressure air through too small a nozzle can be very destructive to the motor insulation.

An excellent plan is to give the motors a thorough cleaning once every six months and at least once every two years give the windings a coat of a good grade of insulating varnish. At this time the bearings should be thoroughly cleaned and refilled with new oil, or repacked with new grease.

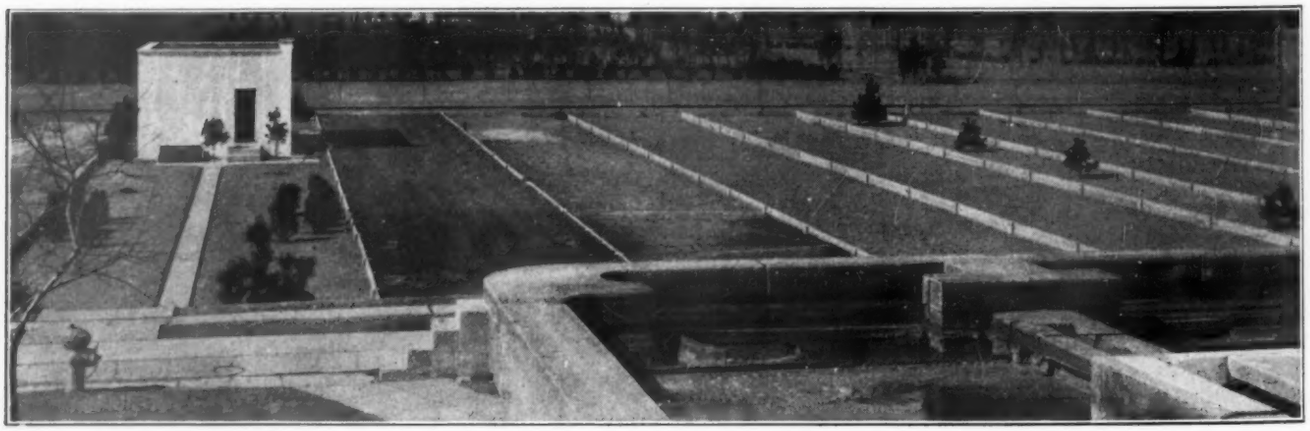
Contactors

Contactors often give an operator more or less trouble due to particles of dust becoming imbedded in the contact fingers. It is a good plan never to use any lubricant on the main contact tips which are mostly constructed of copper, as oil or grease has a tendency to shorten the life of these items. If they should become pitted or burned, which in many cases cannot be avoided, remove the contact tips and clean up with a smooth file or very fine sand paper. Care should be taken when attempting to clean contacts in place not to bend or misalign the parts.

If the operating force is large enough it is a good policy to assign different parts of the equipment and pumping station to the shift operator or oilers and set up a system whereby the entire equipment and pumping station is cleaned at least once every month from top to bottom, besides the daily routine sweeping, mopping and dusting.

Insurance in Cleanliness

This, however, does not mean that the equipment should be dismantled and reassembled but it is important to get the dust and dirt, which is on the surface, before it has a chance to penetrate to the vital parts of the machinery. It will not work a hardship on any member of the operating force to do a little cleaning now and then, no matter what the title of the job he holds. By doing this a man gets around and has a chance to inspect



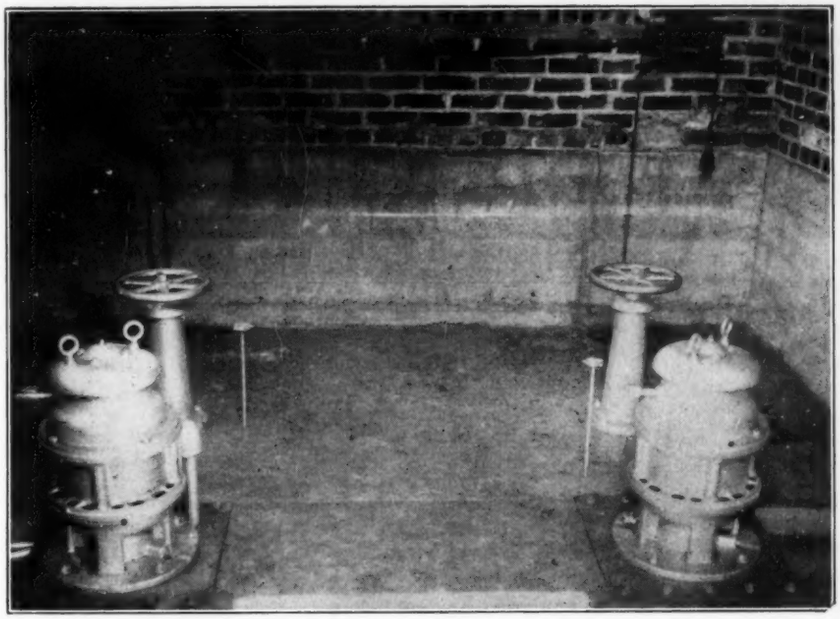
Tidy "Back Yard" of Trenton's Treatment Plant
A Corner of an Imhoff Tank and Sludge Beds Beyond

parts of the equipment which he otherwise would not give a second glance unless trouble should develop in that particular spot.

To be clean is to be free from dirt, odor and keep tidy. There is no reason why a pumping station should not be kept clean, no matter what type—water or sewage. A little attention to cleanliness will result in continued satisfactory operating results and enable the operator to get the most efficient results and best service out of the equipment for many years.

Thoroughness

Maintenance of any piece of equipment should be as thorough as a doctor's examination, not just the usual haphazard method of looking or just glancing in the direction of the machinery. A system of inspection should be drawn up and followed to the letter.



A Lift Station on Trenton's System

Commutators and Brushes

Detailed inspection of motors, shafting, electrical equipment, pumps and piping should be done by men qualified through years of experience for they know what to look for in each unit.

In the case of single phase motors, commutators become rough and burned through continuous operation, dust and oil accumulating being the chief cause. Commutators should be polished with sand paper on a flat block of wood so that the insulation between the segments will be cut back even with the copper. Under no circumstances use emery cloth or emery paper in this operation. A commutator hone with the correct radius is the most efficient tool to use for this purpose.

The brushes should move freely in the brush holders, with the proper spring tension as recommended by the manufacturer. If they do not move freely, a good contact with the commutator will not be made during the starting priod. Both brushes and brush holders should be inspected periodically to see that the brushes have not worn down to a point where they are so short that the brush holder springs cannot press the brushes against the commutator, thus causing burning of the brushes and commutator through arcing.

Motor-cleaning

It is a good policy in the case of single phase motors, having a short-circuiting device, to overhaul once every year. Motors of this type are hard to clean if not dismantled and every part thoroughly washed. There should never be any trouble at this point except for an abnormal accumulation of dirt or frequent overloads in excess of the maximum capacity of the motor.

The normal running temperature of an electric motor is considered a few degrees above the room temperature and should never be allowed to exceed the general standard of forty degrees centigrade above surrounding atmosphere. Motors will carry a full load continuously with no cause for concern if the room is well ventilated. Overloads or undue friction in the bearings will cause the temperature to rise and should be investigated immediately to remedy the trouble.

Motors of different sizes have their own peculiar sound when running, so an operator after a time will become accustomed to this sound and should any noise not characteristic to the motor develop, he will immediately detect it and look for the trouble and remedy it before any damage has been done.

Shafting and Bearings

Shafting in any plant requires attention more often than other parts of the equipment, to insure the longest possible life of the shaft and the shaft bearings. Shaft alignment may be as true as it is humanly possible to make it, but it will not necessarily stay aligned. A bearing wearing due to friction may cause a slight whip in the shaft and be transmitted to the other shaft bearings, thereby causing added play from vibration. A periodic check of the shaft alignment is most advisable.

Bearings on any shafting should be painted a light color, so when a bearing gathers too much heat the paint will discolor and can be detected immediately. Many plants have a thermal over-load device which stops the unit when too much heat develops in any shaft baring. The operator must go to the bearing indicated on the panel and reset the overload switch before the machine can be started again.

In plants which do not have such a device to depend on an operator must go to each bearing and rely on his sense of feeling, even this method will not tell the true story. A thermometer should be used in any and all cases where there is a suspicion of too much heat. Generally after a bearing has carried excessive heat it is too late even for a thermometer, instead a new bearing is indicated, this being true where periodic inspection is deficient.

When a shaft bearing becomes worn, no matter how little it is false economy to leave it in service. Worn shafting will vibrate and promote undue wear on both motor and pump bearings where direct connected. A bearing in this instance would be cheaper to replace than try to get by with, as possibly a whole section of shaft or motor and pump bearings will be ruined in a short time.

In stations that are automatically controlled by float or pressure switches and no attendant is on duty any length of time, it is advisable to paint the shafting to protect it against

rusting. No metal will gather rust more quickly than a highly polished piece of steel. By doing this the unit can be wiped off and be kept clean.

Polished shafting should never be cleaned while the machine is in operation. Although a much better job can be done it is a very dangerous practice. Use of emery cloth should be avoided as the residue may enter the shaft bearing boxes and cause trouble. A good cleaning with soap and water and polishing with metal cleaner will give the best results and not endanger the man doing the cleaning.

It is very important to have uninterrupted operation in many plants, where no standby units are installed. In case of power failure sufficient emergency lights should be available and special jumpers made up for continuous operation in case of burned out starters, float switches, etc.

Emergency Wiring

Rubber covered elevator cable is the most desirable material for emergency wiring, using copper lugs at either end of each wire. This will simplify connecting to the motor and main or branch switches, thereby removing from service the broken starter or float switch. Manual control will be necessary in the case where the float switch is not working. The size of the wire used for jumpers depends upon the size of the motor. This, however can only be applied to small low voltage motors of the "across the line" type. In case of large motors such as 50 HP, 2,300 volt, consult an electrical engineer for advice.

Pump Care

Necessary tools and equipment should be on hand in case of pump failure due to clogged impellers or any overload which would cause fuses to burn out or overload switches to kick out. Any pump being overloaded can be detected by the sudden rise of the ammeter.

Wearing rings in the pump case and on the impeller should be checked occasionally for clearance by using a thickness gauge. Install new rings when the gap has become large enough to impair the efficiency of the pump. New rings installed will improve the pumping capacity, thereby effecting a saving in the electric power consumption.

Packing Pointers

A most important factor, one which can cause much annoyance to the operator and plenty of damage to a pump is the proper size and grade of packing. For pumps handling dirty water — sand and grit — a packing should be selected with some thirty-five per cent lubrication, thus saving the sleeves from being worn too quickly and excessive seepage at the stuffing boxes. No gland should ever be pulled down with a wrench except at such times as to effect the proper seating when new packing is installed. Stuffing box gland nuts should never be more than finger tight, as too tight a packing will cause a braking effect on the pump shaft thereby overloading the motor.

Care should be taken when repacking any piece of machinery to see that the strands do not twist while being forced to the bottom of the stuffing box. Never under any circumstance use more packing in a stuffing box than is absolutely necessary to keep the pump from leaking at this point.

Consult a packing engineer if in doubt as to what grade of packing the unit may require. Experimenting with packing in a pump sometimes is very costly.

The piping in most instances will require little or no attention other than caulking a few leaks that may develop, or removing clogging material which can readily be detected by the use of an ordinary steam pressure gauge. A sudden rise of the gauge when connected to the force main will indicate clogging. It is of course necessary to know the normal reading for comparison.

Check Valves

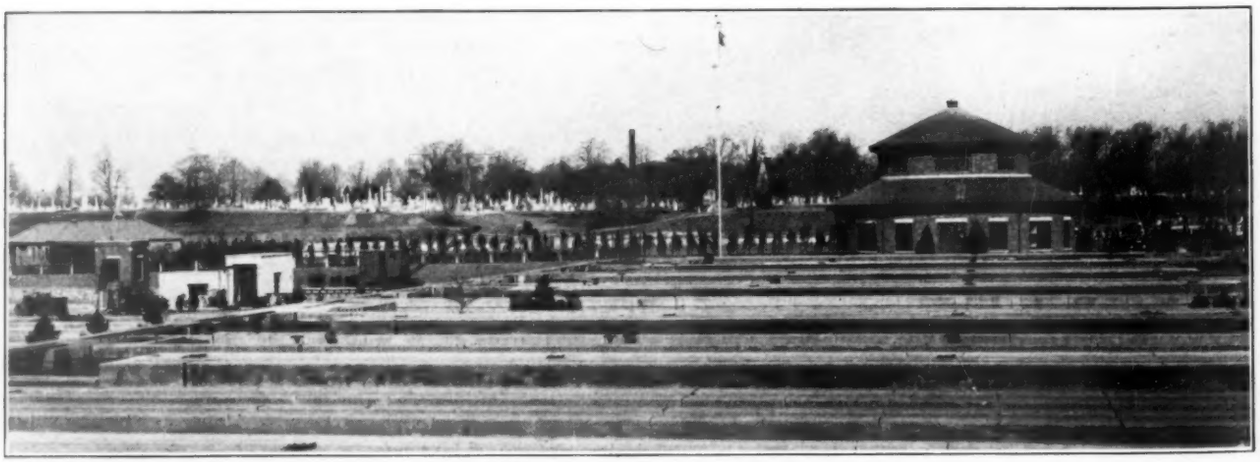
Check valves should be inspected at least once every six months, including internal parts. At this time the seats, clapper faces, and whole interior can be thoroughly cleaned. At more frequent intervals test valves for tightness. Manila paper should be used for the cover gasket after being well oiled with machine oil before installing.

The building housing the equipment must be maintained as well as the machinery. The roof must be kept in constant repair so there is no possibility of water leaking through on the electrical apparatus thereby causing untold damage. Floors should be painted and rubber matting placed thereon at points in front and rear of the switchboard to protect the operator and on the floor where traffic is the heaviest, for appearance. Walls in the dry well should be inspected and repaired when necessary to prevent any seepage of sewage or ground water.

All wood work in the entire building should be painted or varnished at least every two years to protect against dampness, also to keep the appearance of the station up to par. Costly repairs may be caused by neglecting any part of the building.

Tools

It must be understood that no person can do repair work without the



The Treatment Works of Trenton
One Battery of Imhoff Tanks and Pumping Station

proper tools. A suggested list of tools to be included along with those supplied by the pump manufacturer are:

Tool List

Socket Wrench Set (sizes 7/16" to 1⅛" inclusive).

Pliers—2 pair (1—slip joint; 1—side cutting)

Screw Drivers—set of 3 (3, 4 and 6 in. blades).

Stillson Wrenches—two (one 10" and one 18").

Hammer (machinist's, 2 pound).

Oil Cans — 3 or 4 (spout oilers, plainly marked as to contents).

Putty Knife (for scraping old gaskets from pump casings).

Thickness Gauge (for spacing and setting couplings and checking clearances of pump rings).

Packing Tools—full set for removing and replacing packings in stuffing boxes).

Assorted Packings (of pump mfgr's. recommendation).

Spirit Level (machinist's level of dependable make).

Fuse Puller.

Voltage Tester.

Too many so called mechanics of the Stillson wrench type do more damage to machinery attempting an overhaul job than several years of wear and tear, to which the machine is subject. A plant of any size should have among the personnel, men capable of doing all minor and most major repairs, thereby effecting a substantial saving in a year's time over hiring outside mechanics or specialty men to come in and make these repairs.

Spare Parts

Adequate spare parts should be kept on hand at all times to replace worn out or broken parts of the equipment thus saving time. In many cases a unit may be out of service several days waiting for some part whose initial cost may be less than $5.00. Of course, it would be practically impossible to keep enough spare parts on hand to cover the entire equipment. However, essential parts: such as holding coils for contactors likely to burn out any time, and such parts that have to be made up special at the factory, taking 10 to 30 days for delivery, should be stocked.

A most important item in the operation of a plant is the budget. No matter how well the equipment is maintained, normal wear and depreciation must be taken care of. It is false economy to repair only one part of the machine and not replace all the worn parts, just to save a few dollars temporarily.

The old cry is heard many times about effecting economy by using drastic and scientific measures which look very good on paper but in general practice are not worth a second thought, compared to the cost that is likely to be involved by delaying necessary repairs.

Worth of Record Keeping

Keeping records of plant operation is an important factor. Although at the time of recording the data compiled may not seem to be of any significance, it later can be used as a reference for comparing the upkeep, electrical energy required by the different units and depreciation. An excellent method to follow is the frequent reading at stated intervals of all instruments and gauges on the units that are operating, making notations from time to time of any adjustments together with the routine work as required of an operator while on duty. Daily tabulation of all charts and logs will readily tell the story of how the plant is operating—normally or otherwise. At the end of each month the daily tabulations can be set up in the form of a monthly report, showing for example, amount of rainfall, daily pumping average, daily maximum and minimum flow, amount of screenings and grit removed, and amount of sludge removed from different tanks.

The above data can easily be transformed into a yearly report going into more detail if necessary to show the cost of pumping and treating the sewage.

In conclusion, an operator without the aid of expensive testing instruments can readily operate a plant by using some degree of intelligence and the better known common sense. His natal equipment of eyes, ears, nose and sense of touch are all invaluable aids provided, of course, that his head is something better than a hatrack.

BOILER TUBE BUCKLING

An Explanation of the Phenomena

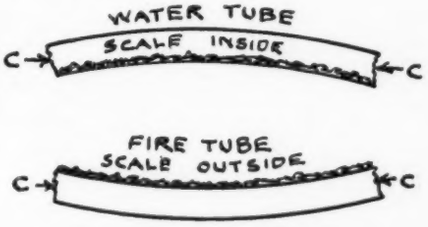
It has been observed many times that when tubes in horizontal water tube boilers buckle, they buckle upward. And on the other hand in the fire tube type of boiler the tubes buckle downward. Why?

The sketch herewith shows why the tubes in the two types of boilers buckle, as they do, in opposite directions.

When the steel of which boiler tubes are made becomes heated, it naturally weakens, and therefore the hottest side becomes the weakest side. In the water-tube boiler the weakest side is on the bottom because the bottom, receiving the hottest blast of the fire, is hottest.

The forces "C" (see sketch) acting on the tube, when in operation, are compressive forces and are equal and opposite in direction, acting from the ends of the tubes. The hottest side compresses more readily than the cooler side, and therefore in the case of the water-tube boiler the buckling is upward.

For the same reason with the fire travelling through the tubes the upper side in the fire-tube boiler is the hottest and therefore the weakest side. Consquently th buckling is downward (see sketch).



Buckling Boiler Tubes
Fire-Tubes Downwards—Water Tubes Upwards

A Further Cause

Another contributory cause is soot. Soot and ash always deposits to greatest depth on the top or outside of the horizontal water tube boiler. The top side is therefore insulated against heat while the bottom is not. And in fire tube boilers soot and ash deposit on the bottom or inside of the tubes. Therefore the bottom is insulated against heat while the top is not. In other words it is perfectly natural for horizontal water tubes to buckle upward and for fire tubes to buckle downward.

If the buckling were caused solely by the expansion due to the difference in temperature on the two sides—assuming no change in strength—the buckling would be in the direction opposite to that shown in the illustrations.

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SEWAGE FILTRATION WITH SILICA SAND FILTERS

Part 2—Recently Developed Mechanically Cleaned Sand Filters and Performance Records

This is the second of a three part article dealing with mechanical filters in sewage treatment. In our August issue the first installment reviewed some of the history of and experiences with mechanical sand filters, with particular reference to basic considerations in design and the merits of shallow filter beds over deep beds.

The third and final installment will comprise a searching analysis and enlightening discussion of the potentialities of effluent filters in the economy of sewage and waste treatment, with particular reference to permissible modifications in plant design and the possibilities therewith in reducing capital investment for treatment facilities.

By PHILIP B. STREANDER
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IN PART I of this article reference was made to two types of mechanical cleaners at present available for silica-sand sewage filters. One type, known as the "Municipal" Sand Cleaner is manufactured by the Underpinning & Foundation Co.; the other by W. C. Laughlin, who earlier introduced the magnetite self-cleansing filter. Both cleaners make use of traveling caissons mounted over the sand bed. Inside of the caissons is the cleaning mechanism, but the two mechanisms differ greatly in their design and arrangement.

In the "Municipal" cleaner the sand is lifted from the bottom of the bed. The sand lifting element sketched in Fig. 8, consists of a jet placed at the entrance to lifting tubes of which there are several in a row, as revealed in Fig. 9. With the wash water being discharged through these jets at high velocity, each acts as an ejector, lifting the sand from above the supporting screen and discharging it immediately above the sand bed level. Hoods are provided over the tube outlets to deflect the sand horizontally backward. The sand falls back over the screen and the turbid matter passes into the moving caisson (Fig. 10), from which it is removed by means of a suction pump mounted thereon. The cleaning of the sand is effected entirely within the lifting tubes where the high velocity jets impinge against the sand in the tubes. The violent scouring action thus secured loosens the dirt within the voids of the sand bed and that tending to adhere to surfaces of the sand particles. Tests made of the actual cleaning action shows removals of between 85% and 90% of the trapped solids. Such was shown graphically in Fig. 3 which accompanied Part I of this article in the August issue.

The caisson and the cleaning mechanism (Fig. 10) are mounted on and supported by a mechanically operated bridge mechanism. The side and bottom views of the cleaner (Fig. 9) shows the location and arrangement of the sand shoes and the entrances to the lifting and scrubbing tubes. This particular cleaner is 2 ft. wide by 3 ft. 6 in. long and has 8 sand lifting and scrubbing tubes.

In the installations so far made the sand has a size of about 1 millimeter and 1.5 uniformity coefficient. The

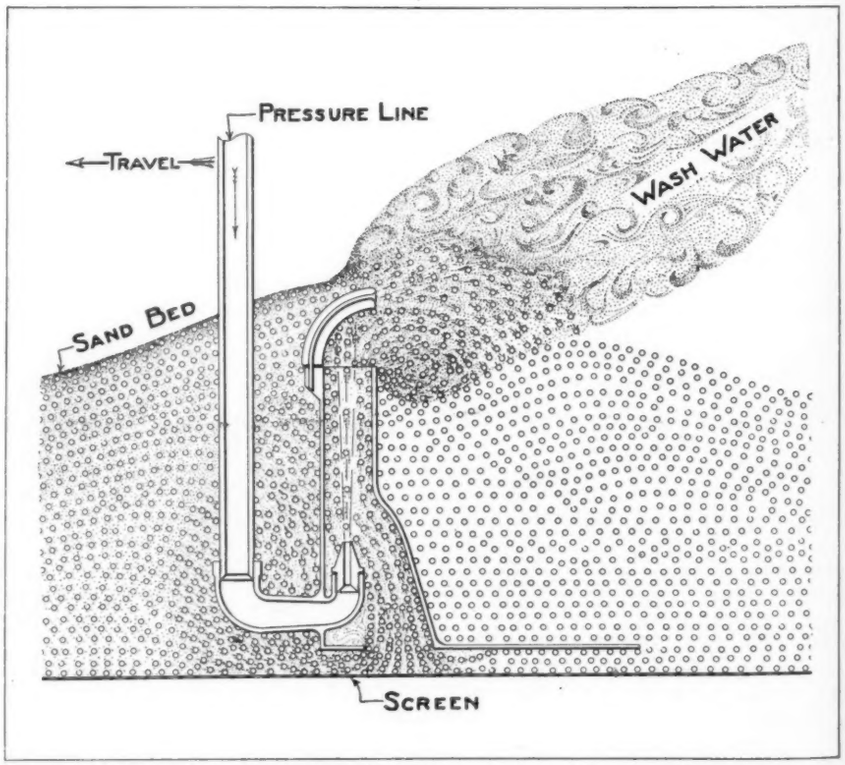

Fig. 8—Sketch of the Sand Scouring Element of the "Municipal" Jetting Type Cleaner in Action

(Tests reveal that 86% of the solids trapped in the bed are removed during a single pass of the cleansing battery of jetting "boots" shown in Fig. 9)

bed is 6 inches deep and is supported by means of a perforated plate screen. The cleaner travels at a speed of about 7.5 feet per minute and each cleaning operation consists of a full traverse of the bed. The capacity of the dirty wash water removal pump for the 8 unit-cleaner is about 120 to 130 gallons per minute. Considering the 7 square feet of caisson area this results in a wash water rate of about 17 gallons per square foot per minute, corresponding to a vertical rise of about 27 inches per minute. At the four plants where these filters are at present in use two are operating in conjunction with chemical treatment and the other two serve with chemical treatment or plain settling as desired, the filters handling tank effluents in each instance. The designed filter rate was 0.64 gallons per square foot per minute and in three of the plants the present normal flow gives such rates of filtration. The average daily maximum rate is only about 0.85 gallons, whereas peak hourly flows necessitate a filter rate as high as 1.7 gallons per square foot per minute.

Performance Tests

Suspended solids observed during tests at the plant of South River, N. J., were plotted in test days, according to the strength of the raw sewage. The test data given are based on plain settling only, using no coagulating chemicals, and are presented in Fig. 11. It is interesting to note the comparative uniformity of the filtered effluent regardless of the variation in the solids contained in the settled sewage applied to the filter. The results secured during the 45 day official continuous operation acceptance tests at the South River and Sayerville plants (with and without chemical treatment) are revealed in the tables following.

Special investigations of these two plants, involving complete 24 hour tests, were made by the New Jersey State Department of Health. Complete analyses were made on 24 hour composited samples of raw sewage, flocculated sewage, settling tank effluent and the chlorine contact tank effluent. The tests made included total solids, suspended solids, nitrogen, alkalinity, oxygen consumed, chloride and 5 day B.O.D. values. Consideration of the low reductions effected by the settling tanks alone indicated these units to be of rather small diameter for circular settling tank design. Such a conclusion is based on the heavy solids loadings observed on the sand strainers. Performance of the

SOUTH RIVER PLANT 2 UNITS OPERATED	Chemical Treatment 23 days	Plain Settling 22 days
Average daily flow	0.70 M.G.D.	0.75 M.G.D.
Maximum daily flow	0.88 "	0.99 "
Minimum daily flow	0.52 "	0.63 "
Ave. Susp. Solids		
(a) Filter Influent	60 ppm	135 ppm
(b) Filter Effluent	30 ppm	65 ppm
Removed by Filters	30 ppm	70 ppm
Cleanings per Day	9.8	16.6
Power Required	10.3 KWH	16 KWH

SAYERVILLE PLANT 1 UNIT OPERATED		
Average daily flow	0.34 M.G.D.	0.34 M.G.D.
Maximum daily flow	0.46 "	0.37 "
Minimum daily flow	0.29 "	0.30 "
Avg. Susp. Solids		
(a) Filter Influent	53 ppm	118 ppm
(b) Filter Effluent	27 ppm	58 ppm
Removed by Filters	26 ppm	60 ppm
Cleanings per Day	7.4	7.4
Power Required	8.1 KWH	8.1 KWH

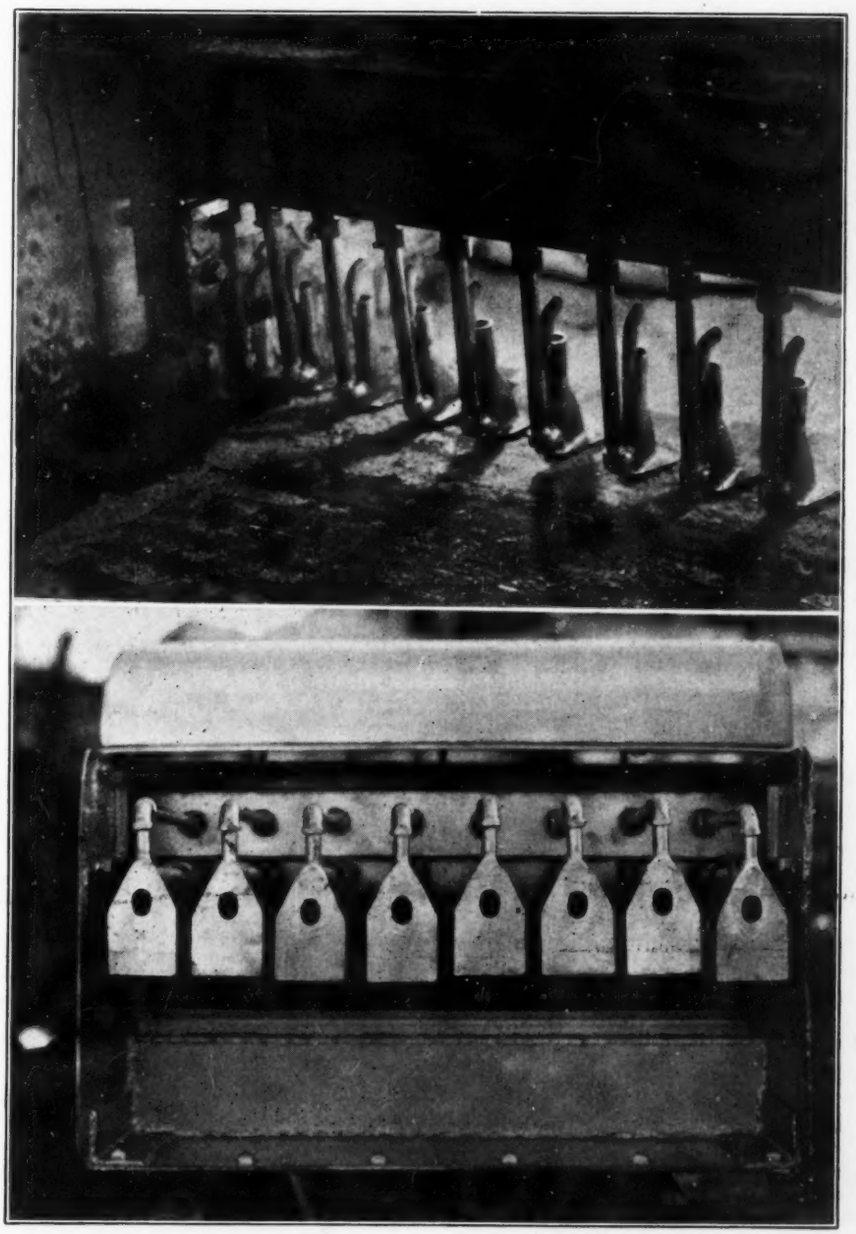

Fig. 9—Side and Bottom View of an 8 Unit "Municipal" Cleaner
(The action of each of the jetting boots is pictured in Fig. 8. Note how closely these boots travel above the screen supporting the bed)

settling tanks and sand filters, as reported by the State, were as shown in the tables following.

The analysis of the 24 hour composited samples at the two plants are shown in the following table. It is to be noted that the special test at the South River plant was made on plain settled sewage whereas at the Sayerville plant tests were made during plain settling as well as during chemical precipitation. All results are expressed in p.p.m.

The results secured during the tests are shown graphically in Figs. 12 and 13. These graphs have been prepared to reveal the hourly variations in suspended solids in the filter influent and effluent. The washing periods are shown on the Sayerville chart.

Of interest in the foregoing tests are not only the reductions effected by the filter in suspended solids, but also the reductions in 5 day B.O.D. and oxygen consumed. The former is a measure of the total oxygen consuming impurities in the sewage and, according to the tests, the reduction effected by the sand strainer was between 13 and 28 percent, when filtering settled sewage. During the reduction in loading on the filter, as the result of chemical precipitation, the filter accounted for roughly a 10 percent reduction only. The reduction in oxygen consumed (carbonaceous impurities) was about 20 per cent when filtering plain settled sewage.

Filters Remove More Than Settling Tanks

At these two plants the effluent filters actually removed more suspended solids than did the settling tanks. Without the effluent filters the results would have been somewhat less than average reductions effected by primary treatment plants. With chemical coagulation the efficiency of the settling tanks was naturally higher, but even with chemical treatment the effluent filters materially reduced the suspended solids that would otherwise have been discharged into the river, and resulted in a far more pleasing effluent in appearance. The loss of head through the filters averaged between 1 and 2 inches.

SOUTH RIVER—(No Chemicals)

	% Removals by Settling Tank	% Removals by Sand Filter
Suspended Solids	27%	47%
5 day B. O. D.	15%	28%
Oxygen Consumed	21%	19%
Total Nitrogen	2%	9%

SOUTH RIVER—(No Chemicals)

	Raw Sewage	Floc. Tank Effluent	Clarified Effluent	Filter Effluent	Wash Water
Total Solids	812	622	491	405	1447
Suspended Solids	182	226	132	70	1148
Total Nitrogen	48	46	47	42	98
pH	6.3	6.2	6.3	6.4	6.3
Oxygen Consumed	79	76	62	50	224

Rate of flow 0.62 M.G.D.
Rate of filtration (average) = 0.62 g.p.m./s.f.
Max. Hourly Rate = 1.71 g.p.m./s.f.
Times washed per day = 12.7
Total washing time per day 190 minutes
Total wash water (23,000 gals. per day) = 3.7 percent

SAYERVILLE

	No Chemicals % Removals by Settling Tank	No Chemicals % Removals by Sand Filter	Chem. Coagulation % Removals by Settling Tank	Chem. Coagulation % Removals by Sand Filter
Suspended Solids	29%	51%	90%	5%
5 day B. O. D.	35%	13%	62%	9%
Oxygen Consumed	21%	14%	63%	4%
Total Nitrogen	5%	8%	23%	—

SAYERVILLE—(No Chemicals)

	Raw Sewage	Floc. Tank Effluent	Clarified Effluent	Filter Effluent	Wash Water
Total Solids	545	653	485	434	1495
Suspended Solids	216	316	154	76	1160
Total Nitrogen	49	49	47	43	89
pH	6.8	7.1	7.2	7.1	7.0
Oxygen Consumed	88	86	69	57	210

Rate of flow 0.35 M.G.D.
Rate of filtration (average) = 0.60 g.p.m./s.f.
Maximum hourly rate = 1.14 g.p.m./s.f.
Times washed per day—9
Total washing time per day = 135 minutes
Total wash water (16,500 gals. per day) = 4.7 percent

SAYERVILLE—(Chemical Treatment)

	Raw Sewage	Floc. Tank Effluent	Clarified Effluent	Filter Effluent	Wash Water
Total Solids	629	877	451	449	838
Suspended Solids	406	512	40	20	528
Total Nitrogen	53	52	41	41	58
pH	8.0	9.0	9.0	8.9	9.0
Oxygen Consumed	98	88	36	34	107

Rate of flow 0.35 M.G.D.
Rate of filtration (average) = 0.60 g.p.m./s.f.
Maximum hourly rate = 1.15 g.p.m./s.f.
Times washed per day—8
Total washing time per day = 120 minutes
Total wash water (14,400 gals. per day) = 4.1 percent

Effects of Washing on Efficiency

In addition to the tests giving the distribution of the retained solids in the sand bed, and the removal of these by the cleaning mechanism, tests were conducted to show the amounts of suspended solids in the filter effluent during the bed cleaning operations. It must be remembered that in these plants the effluent filters are an integral part of the settling tanks and cannot be out of service while they are being cleaned. This then requires that a part of the sand bed be cleaned while sewage passes through other parts. With such operation it is natural that the suspended solids in the effluent should increase during the periods of washing. The explanation is found in the fact that during the cleaning period the major portion of the sewage passes through that part of the bed offering the least resistance to flow; therefore, when the cleaning begins, there is a rush of

sewage through the cleaned portion of the bed and the filtering rate through the cleaned part is several times the normal rate. Should the sand not be thoroughly cleaned, or only agitated, the higher rate of flow would force the disturbed solids through the bed and into the effluent. These solids would be additional to those normally passed through the bed at the higher rates of flow. As revealed by the test data the increase in suspended solids in the effluent is pictured graphically in Fig. 14. This chart shows the suspended solids prior to, during the first stages, and after completion of the washing operations, the washing period being 15 minutes. As to be anticipated, the variation with chemically coagulated solids is higher than for plain settled solids, the former being much higher and more easily disturbed than the latter. With chemical floc being removed the increase in suspended solids reached its maximum 5 minutes after the commencement of washing. Then within 10 minutes (two-thirds of the cleaning time) the effluent was back to normal. With plain settled sewage the peak was reached at the 10 minute period,

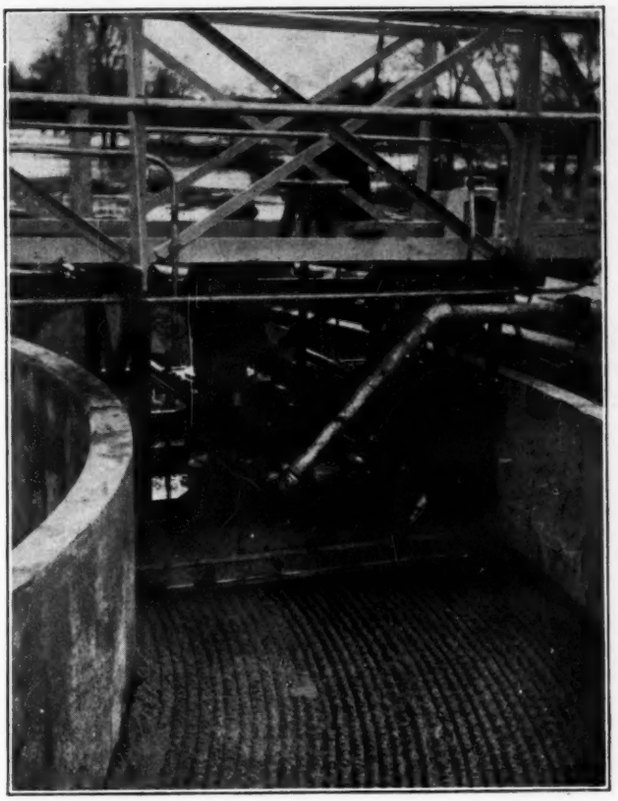

Fig. 10—General View of a "Municipal" Cleaner with Sand Bed in Place
(On the traveling caissons may be seen the wash-pump supplying the scouring jets and the dirty water take-off pump)

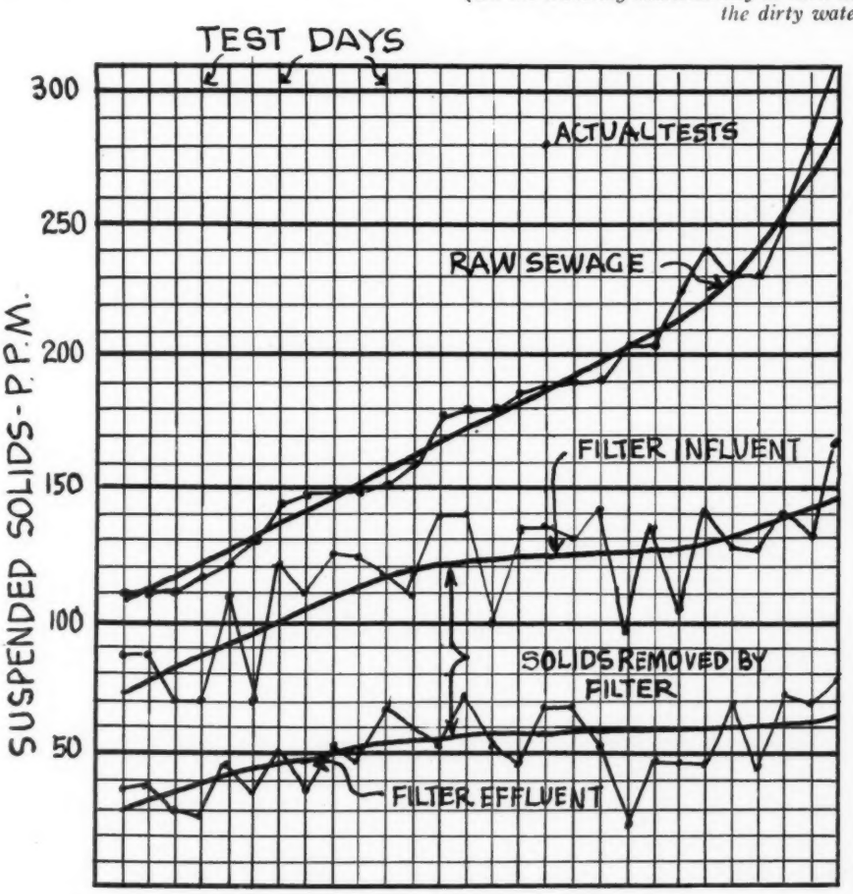

Fig. 11—Results of 30 Day Acceptance Test of the Cleaner at South River, N. J., Without the Aid of Coagulants
(Results are here plotted to indicate performance variations with increasing strength of sewage)

and the effluent did not reach normal until the washing had stopped. It is believed that these conditions are normal for mechanically cleaned beds where the washing is carried on during the filtering operation. Should the short temporary increase be objectionable plants can be designed with separate filter beds, arranged so that during the washing period no plant flow would pass through the filters. Or the effluent could be returned to the raw sewage for a short period of time.

Studies made of the removal of the trapped sewage solids within the filter bed interstices indicated that the efficiency of the cleaner reaches the figure of 85 percent or better, previously given. During the 22 day official test (South River) the solids removed by the filter averaged 70 p.p.m. At the 0.75 M.G.D. average flow this amounts to 440 pounds of solids (dry basis) per day. The cleanings per day averaged 16.6. This at 15 minutes per cleaning gives 250 minutes (4.17 hours) of washing per day. The suspended solids in the wash water averaged about 1750 p.p.m. and deducting the solids in the filter influent (135 p.p.m.), which was used as the pressure and backwash water, leaves a net of about 1600 p.p.m. of suspended

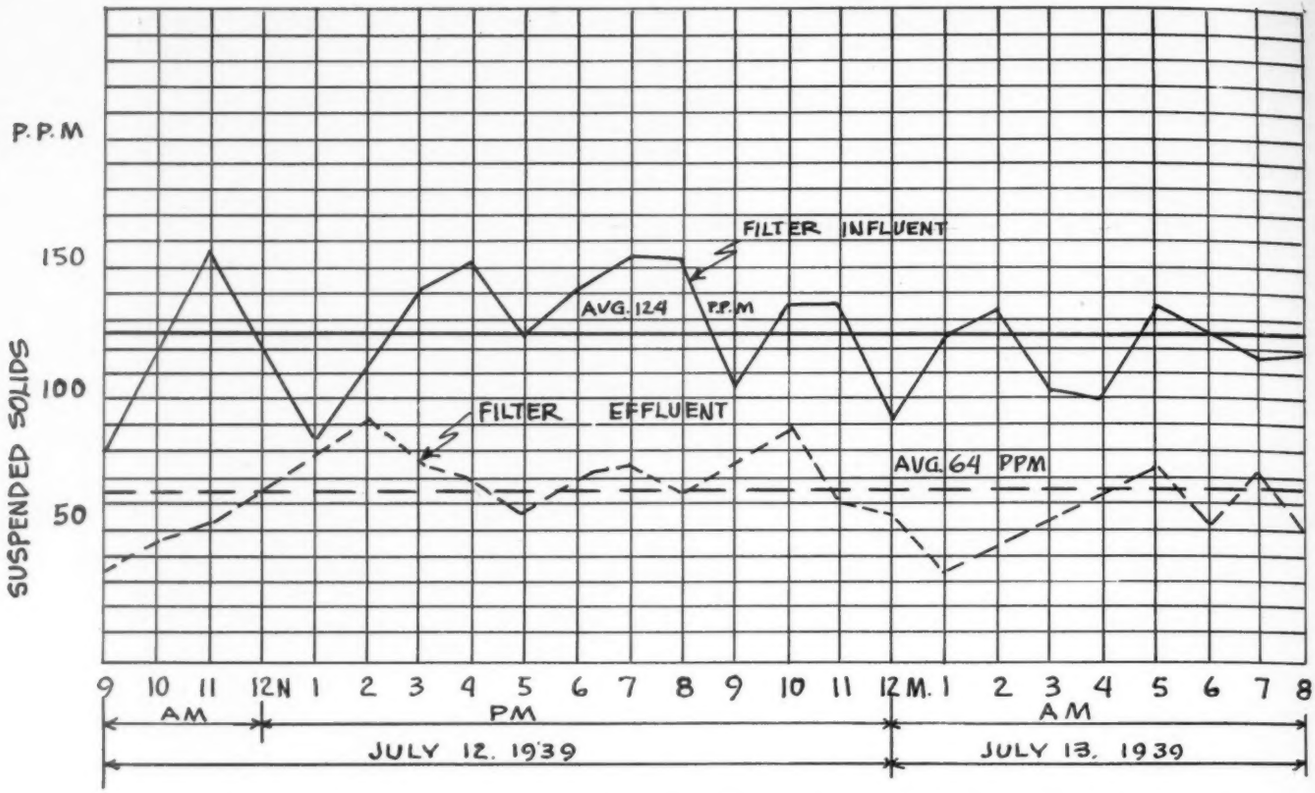

Fig. 12—Typical Hourly Results Chart for 24 Hour Run at South River Plant Without Flocculation of Sewage

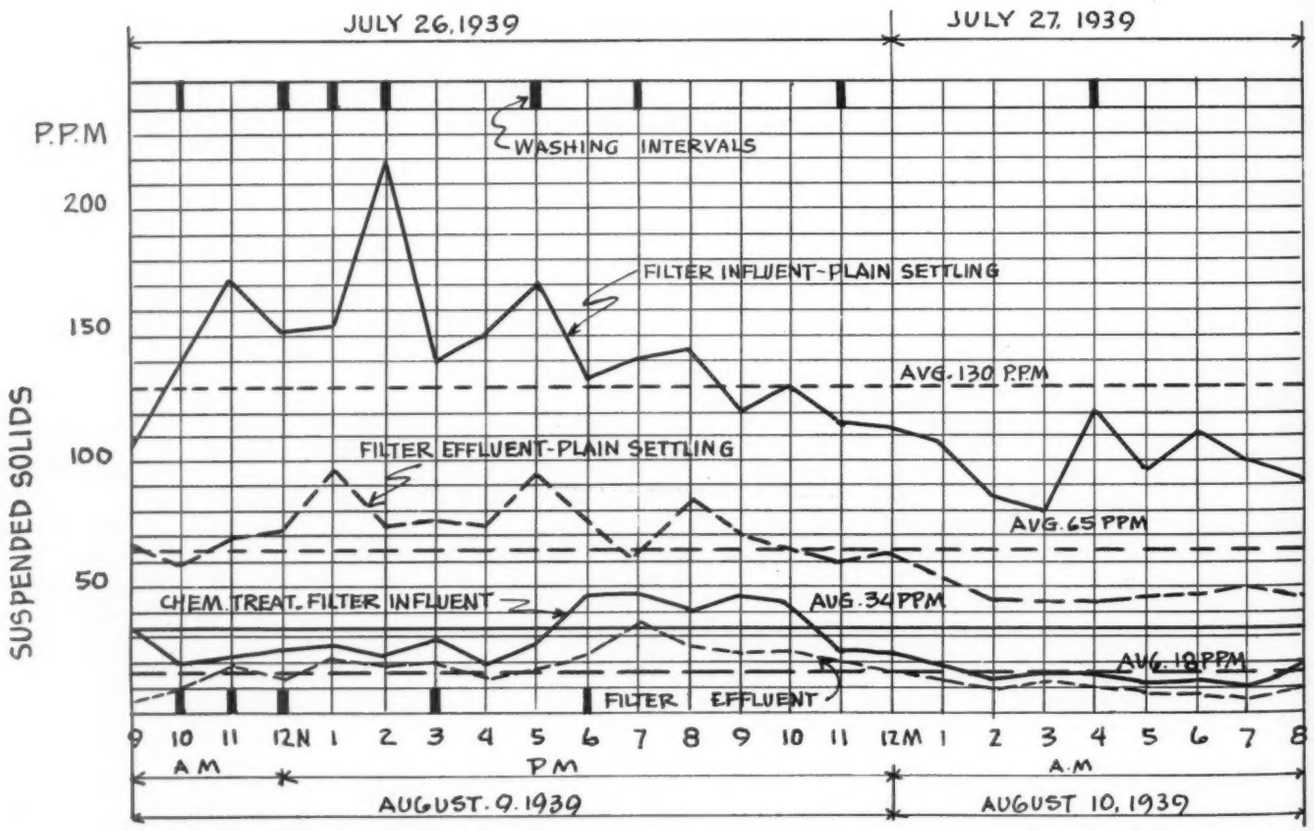

Fig. 13—Comparison of Hour to Hour Results With and Without Flocculation at Sayreville, N. J.
(July 26 and 27 results without chemicals show in upper two lines; during chemical precipitation, August 9 and 10, show in lower two lines. The additional suspended solids reduction accredited to flocculation averaged 47 p.p.m.)

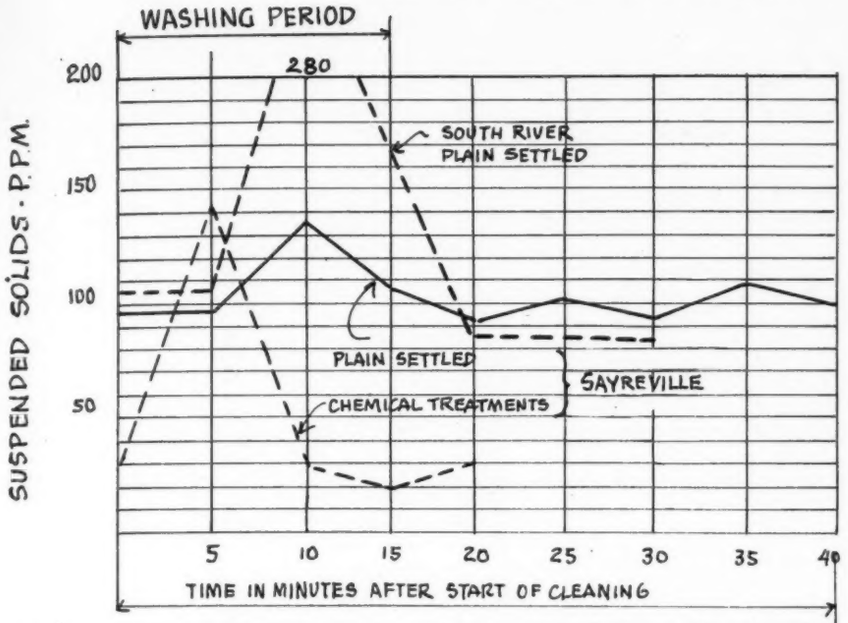

Fig. 14—Effects on Effluent Quality as Result of Functioning of the Cleansing Unit in the Washing Operation

(The effectiveness of chemical flocculation on the speed of recovery of filter efficiency during the washing period is plainly evident in the results at Sayreville)

solids in the wash water. Multiplying these gives about 440 pounds of solids (dry basis) which is the amount removed by the filter.

The Laughlin Filter

Wm. C. Laughlin, in his experimental work, reached the conclusion that the major portion of the solids is retained within the upper part of the bed and that the filter could do more effective work if this part of the bed was maintained in a comparatively clean condition and then only clean the lower part when the solids accumulation in the bed reached a point productive of loss of head in excess of that allowed through the bed. For these reasons Laughlin, in developing his first sand filter, provided two separate units, consisting of an independently operated top cleaner and a bottom cleaner. There are two effective parts in the top cleaner, a cutting blade, running through and lifting the top ½ inch or more of sand, and a rotating paddle that agitates the lifted sand to loosen the sewage solids from the sand. The released solids are pumped out by a sump pump connected to the enclosing caisson and the sand falls back on the surface of the bed.

In Laughlin's first filter the bottom cleaner consisted of a perforated pipe which traversed the bed immediately above the sand supporting screen. It had sand deflecting plows at either side and was supported from the traveling caisson. Pressure wash water was taken from the effluent channel and pumped through the perforated pipe into the lower part of the sand bed. The combined action of the pipe jets and the sand plows is such that the sand is expanded within the liquid and thoroughly scrubbed. The dirty wash water is drawn away from the caisson by a sump pump. If desired, air can also be introduced into the bed through a pet-cock on the pump suction, and distributed with the pressure water used for washing.

The sand bed is about 6 inches deep and is supported on a perforated plate. The underside of the supporting plate is divided into sections each connected by a pipe with the effluent flume. The sand has an effective size of 0.40 to 0.50 m.m. and a uniformity coefficient of 1.80 to 2.00. The top cleaner runs on a time cycle, and is manually set to operate at intervals, as required by the particular sewage being filtered. Its travel speed is about 8 feet per minute. The top cleaner continues its periodic surface cleaning until the accumulation of solids in the body of the bed increases the loss of head to the predetermined maximum. Then a float control starts the bottom cleaning mechanism, which operates at a speed of 4 feet per minute. The number of cleanings will

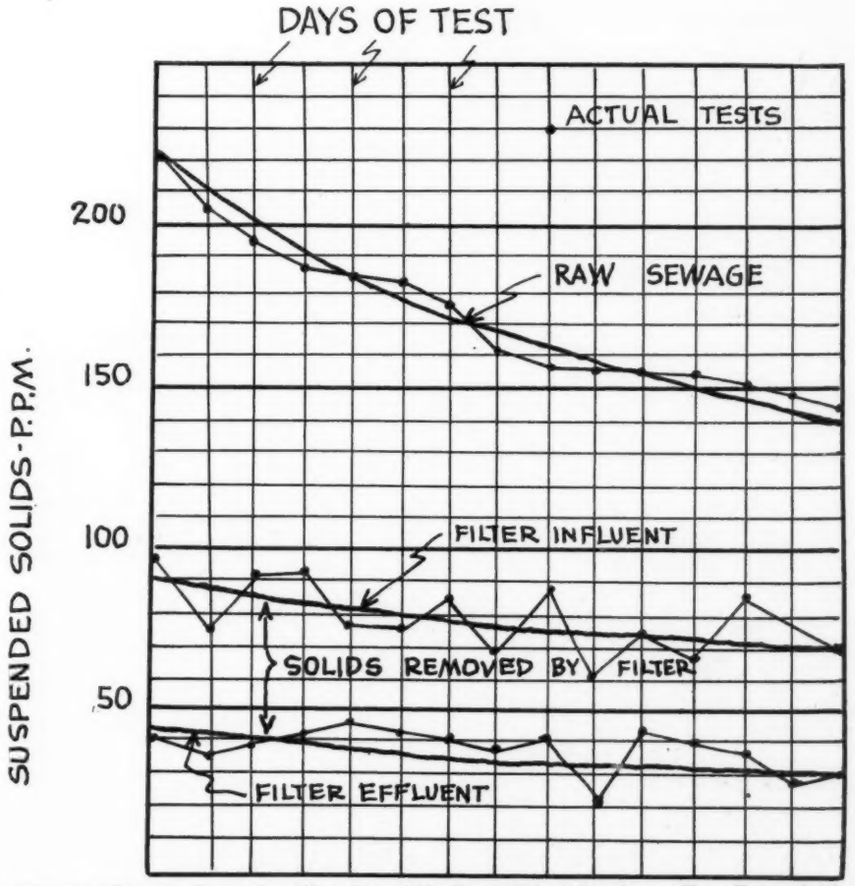

Fig. 15—Results from the First Laughlin Sand Filter During a Test Run of 15 Days at Atlantic City, N. J.

(The results are plotted to reveal the relationship between sewage strength and filter performance)

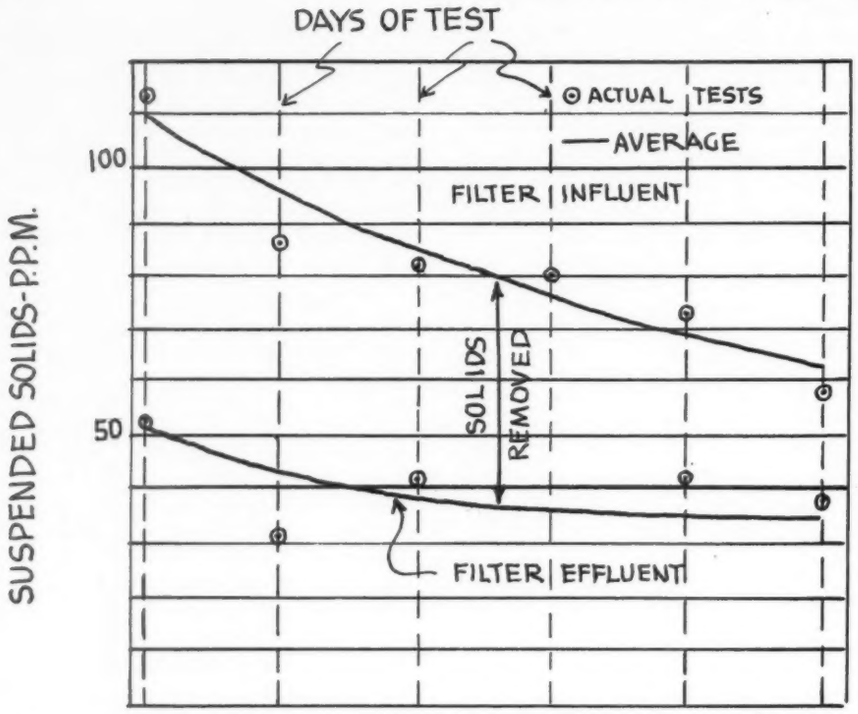

Fig. 16—Results with Laughlin's Filter, Taken from a Report of the N. J. State Dep't. of Health Covering a Test Run at Atlantic City

vary with the strength of the sewage and the loss of head at which the filter operates. The top and bottom cleaning mechanisms were separate entities.

The wash water used by Laughlin's surface cleaner is about 12 g.p.m./sq. ft. of caisson area, corresponding to a rise within the caisson of about 7 inches per minute. The waste wash water removed by the bottom cleaner is about 15 gallons per square foot of caisson area, corresponding to a vertical rise of 24 inches per minute while operating.

There are two installations of this earlier type of Laughlin's cleaner. The first is the demonstration unit handling 200,000 gals./day at the plant of the Atlantic City Sewerage Co. The other is at Piedmont, N. Y., where the waste from a paper plant having four tons of recoverable pulp per million gallons is being filtered. The unit at the Atlantic City plant filters effluent from plain settling tanks, which is entirely domestic but is highly septic. The unit is 2 feet wide by 54 feet long, having an effective filter area of 69 square feet.

Operating Results—Laughlin's Filter

At a rate of 200,000 gals. per day the filtering rate (based on the 69 sq. ft. effective area) is 2 gallons per minute per square foot of filter area. In a series of operations and tests on this plant the suspended solids in the raw sewage, in the settled sewage and in the filter effluent were as shown in the following table. Each run represents a period of about 24 hours of the day and all results are expressed in parts per million.

SUSPENDED SOLIDS—LAUGHLIN FILTER, ATLANTIC CITY

Date 1938	Raw Sewage	Settled Sewage	Filter Effluent
Jan. 8	156	88	40
" 28	147	74	26
" 31	150	84	36
Feb. 1	184	77	45
" 2	188	94	40
" 10	144	67	29
" 11	155	60	19
" 14	198	92	38
" 15	206	76	36
" 17	176	84	40
" 18	162	69	35
" 21	223	95	40
" 28	152	74	44
Mar.31	182	75	42
Apr. 5	152	69	38
Average	172	78	37
Maximum	223	95	45
Minimum	144	60	19

During these 15 days the average reduction affected by the Laughlin filter over and above the settling units was 53 percent. The results are shown graphically in Fig. 15.

In a series of investigations made by the State Department of Health tests were made of the reductions effected by the effluent filter in suspended solids, B.O.D., oxygen consumed and B. Coli. During the tests the filters were operated at a sustained rate of 1.5 gals. per square foot per minute. In the first two tests magnetite sand was used as the filtering medium and, thereafter, silica sand.

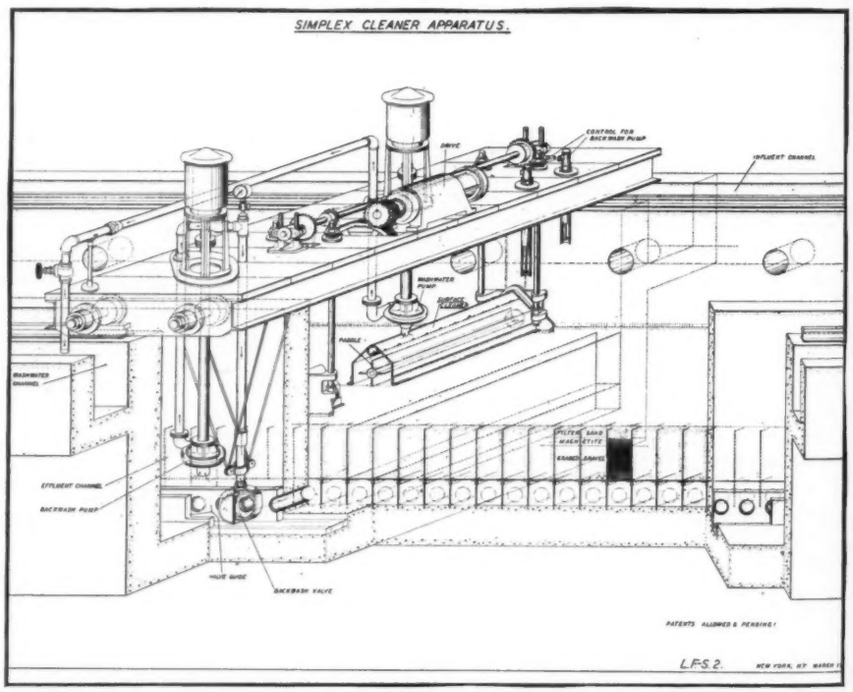

Fig. 17—Phantom Drawing of Laughlin's Improved Filter and "Simplex" Bed Cleaner

(The top cleaner and bottom cleaner have been combined in one traveling mechanism. The bottom wash is now a progressive sectional wash, the filter being essentially a false bottom multi-sectional unit designed for the purpose. Heavy magnetite sand separates the silica sand from the fine gravel)

Following the April tests certain changes were made to the cleaning mechanism to improve its efficiency. The results of the tests on the filter, expressed in p.p.m., were as follows:

Removals by Laughlin Effluent Filters—Atlantic City, N. J.
(State Dept. of Health Records)

		Suspended Solids			Oxygen Consumed			5 Day B.O.D.		
		Influ-ent	Efflu-ent	Reduc-tion	Influ-ent	Efflu-ent	Reduc-tion	Influ-ent	Efflu-ent	Reduc-tion
Magnetite Sand	*Hrs.*									
Mar. 16-16	24	58	38	20	42	30	12	283	202	81
Apr. 26-27	24	81	42	39	41	33	8	198	159	39
Silica Sand										
July 16-17	24	112	51	61	55	40	6	205	150	55
Oct. 16	11	85	30	55	40	32	8	187	128	59
Oct. 17	8	80	32	48	46	32	14	185	133	52
Oct. 18	5	73	42	31	45	39	6	164	.....	....
Avgs. for Magnetite		70	40	30	41	31	10	240	180	60
Avgs. for Sand		88	39	49	47	38	9	185	137	48

The reduction in suspended solids arranged in the order of their magnitude is shown graphically in Fig. 16.

During tests on the silica sand bed the average reduction in suspended solids was 56%, the reduction in oxygen consumed was 20% and the reduction in 5 day B.O.D. was 26%. It is observed that reductions in oxygen consumed and B.O.D. are not in direct proportion to the reduction in suspended solids. However, a consistent reduction was effected by the filter, the test figures showing actual reductions in oxygen consumed varying from 13 to 30% and B.O.D. from 20 to 32%. A probable explanation is the septic condition of the sewage being filtered. Such sewage contains a large proportion of dissolved solids and a large part of putrescibles in a condition not amenable to removal by filtration without pre-flocculation. This may be further verified by the low suspended solids content of the septic tank effluent, indicating that the high bio-chemical oxygen demand of the sewage is due to non-filterable solids rather than suspended solids. As the filter is entirely mechanical in its action, (i.e., no biological or chemical reactions taking place) but little or no effect is to be expected on dissolved solids.

The loss of head during the various tests conducted by the State, and also during the demonstration runs on the filter, ranged consistently between 3 and 6 inches with variations of not more than 1 inch either way. Such observations indicate that the filtering medium was being effectively cleaned. The top cleaner ran on a set time cycle of 30 minutes, and the increase in loss of head was such that the bottom cleaner operated once every 2 to 3 hours only.

The Improved Laughlin Filter

An improved filter has recently been developed by Laughlin, as shown in Fig. 17. The filter bed is divided into sections of 12 inches each, for the entire length of the bed, by means of steel plates extending across the full width of the bed. The bed proper (Fig. 18) consists of the so-called "effective sand" of about 4 inches depth, supported on a 2 inch separating layer of coarse magnetite sand between the silica sand and the graded gravel. The full bed rests on a perforated plate forming a false bottom for each individual section of bed.

As with his earlier type of cleaner, Laughlin provides in this unit a surface cleaner to remove the solids entrained in the upper 1 inch or so of the sand filter. Sub-surface cleaning is done by reversing the flow (backwash) in each of the individual 12 inch wide transverse sectional units. Backwash water is taken from the effluent conduit by means of a pumping unit supported on the traveling bridge. It discharges into the backwash mechanism, which consists of a rubber faced slide valve, traveling in a guide, through which the backwash water is forced in succession into each chamber as it passes by the series of ports. It then flows upward through the 12 inch wide filter section at a velocity sufficient to flush out the solids retained in the lower part of the bed. The backwash water is removed by the surface cleaner, the cleaner and traveling backwash slide valve being on the same center line.

The carriage supporting the cleaning mechanism moves at a speed of about 8 feet per minute, at intervals controlled by an adjustable time switch. As it moves, the surface cleaner continuously removes the solids accumulated in the top part of the bed. When the solids penetrate the bed in an amount sufficient to increase the loss of head to its predetermined maximum, the bottom wash mechanism is automatically cut into service and continues to operate until the head loss through the bed is reduced to its initial value.

[The third and concluding installment of Mr. Streander's article is to follow in an early issue if not in the next.—ED.]

SECONDS BECOME MINUTES
(But Shouldn't in Sludge Lines)

On page 318 of our July issue Stanley Kappe, of the Chicago Pump Co., is credited with stating on the floor of the New York Sewage Works Association Meeting, in a discussion concerning sludge and pumping, that "velocity in sludge lines should not be less than 2 ft./min." This is wrong.

This error of "seconds becoming minutes" between the time Mr. Kappe made his statement and its appearance in print is regretted. His objection is to any volocity under 2 ft./second, if the line is to be kept free of sludge-ring formation, and consequent gradually mounting friction through sludge pumping lines.

Please forgive us, Mr. Kappe; for with your views, we concur. The idea, as we see it, is to specify a good tough pump for sludge; design for roughly 2 ft./sec. velocity through the lines and let the friction take care of itself. It has never paid yet to cut the cloth too fine in sludge pumping arrangements, insofar as assumed power requirement (motor size) or sturdiness of pump construction is concerned. For the reason that friction in pumping lines will in the end "take care of itself" it is a fallacy to design oversized pumping lines for sludge, with the idea of reducing friction head, power requirements and operating costs. It just doesn't work.

DEEP SAND FILTERS FOR SETTLED SEWAGE USED 23 YEARS AGO

(A Letter to the Editor)

From—Louis R. Howson, C.E., Chicago

Dear Sir:—

In your August issue I was interested in reading the first of a series of three articles by Mr. Streander on "Sewage Filtration with Silica Sand Filters." I notice the statement that "several installations of deep bed sand filters have been made in this country for the filtration of sewage effluents * * * They followed trickling filter and activated sludge treatment and the filter loadings were but little, if any, in excess of those common to water filtration plants. No deep bed sand filters have been installed in this country for the filtration of plain, settled or flocculated sewages, nor have any experiments been made thereon."

As early as 1917 the writer's firm designed filters of this type for the Great Lakes Naval Training Station at Great Lakes, Ill., which filters continued to operate for approximately fifteen years. The only preliminary treatment was the passage of the sewage through hopper bottom, plain sedimentation tanks, and withdrawal of the sludge from the hoppers to separate sludge digestion tanks, without roofs or gas collection. In the construction of the plant there was placed between the settling tanks and the filters what were termed coagulation basins. And around the end baffled mixing chamber was provided in which alum could be applied. After a short experimental run with the alum, the plant was thereafter operated without chemicals.

There were four filters, each with a capacity of ¾ M.G.D. at a rating of 1.5 gallons per square foot per minute. The filters were of conventional water works design with high rate water wash, perforated pipe laterals, gravel bed and 30″ of sand having an effective size of .36-.6. The filters were washed with water pumped in from the lake. The wash water used was high, reaching as much as approximately 10% of the sewage filtered.

The effluent was chlorinated. These filters were built to handle the sewage from 35,000 "jackies" but actually took the flow from 65,000 over several months period. The flow averaged about 3 M.G.D.

I am sorry that I cannot give you B.O.D. or bacterial results. So far as the removal of suspended matter was concerned, the filters were quite effective, the sand became quite black with organic matter; the effluent had low turbidity but fairly high color; chlorine did the rest.

I am not sure that the filter end of this plant was ever written up so that this letter is not written as a challenge to Mr. Streander's statement, but simply to record the fact that filtration of sewage following primary treatment only and through deep filters was practiced successfully as long as twenty-three years ago. I thought that both you and Mr. Streander would be interested in this early application.

Very truly yours,
Alvord, Burdick & Howson,
By L. R. Howson

(Note—Mr. Howson sent a copy of this letter to Mr. Streander, who requests if there be other instances in which deep filters have been employed in filtering sewage or sewage effluents that letters to "Water Works & Sewerage" advising of such will be appreciated in order to make the record accurate and more complete.—Ed.)

A.W.W.A. NOW HAS CUBAN SECTION

The Cuban Section of the American Water Works Association is now a going organization. This snapshot was taken of the head table at the organization breakfast held at the Havana Yacht Club.

From left to right in the picture are—Col. W. F. Rockwell of Pittsburgh Equitable Meter Co., President-Elect of the Water Works Manufacturers Ass'n.; Dr. Domingo Ramos, the Cuban Secretary of Defense; Edwardo J. Chibas, newly elected President of the Cuban Section; Norman J. Howard, President of the A.W.W.A., who came down from Toronto for the occasion; and Francisco Gaston, President of the Cuba Society of Engineers.

Lawrence H. Daniel, of Daniel, Inc., Havana, active in organizing the Section, has been elected its Secretary-Treasurer, and Juan A. Cosculluela, Cons. Engr. of Havana has been elected to serve as the Cuban Director on the A.W.W.A. Board. Mr. Cosculluela is no stranger to those attending Florida Section meetings because he has for several years been a consistent attendant at these.

The new Section starts with 28 active members and 1 corporate member.

GOOD PUBLIC RELATIONS - THE NO. 1 ASSET*

Some Experiences in Operating a Small Water Works Property

By PAUL KILLIAN, Manager
Peoples Water Service Co.
BRUNSWICK, GEORGIA

IN MY opinion, no one factor contributes more to the well-being of any business than the existence of favorable "public relations," in other words that asset of assets known as "Good Will." Business management of today is recognizing this to be true more than ever before.

"Life Blood" of a Public Utility

The usual lack of competition in the utility field makes its public relations more important than in any other sort of business. It has been my observation that the "average customer" of a utility is naturally and inherently suspicious. In the case of a water utility this is particularly so because water is so freely distributed over the face of the earth that the customer is likely to feel that he is paying for something which is "God-given," and its sale is of the nature of profiteering.

During the life time of most of us here today, wells were dug in our own yards, before the days of water distribution systems, as we know them today, with all the appurtenances and we used this water freely and without cost. It is hard to overcome prejudice within a span of a few years, or even a generation, of having water measured to us through meters and receiving a bill for it at the end of the month.

People have had to be educated, and many must still be educated, as to what is entailed in the collection and distribution of water. They must be brought to the realization that, with the growth and development of our natural resources, that a new motif of life has changed the entire structure of living conditions.

With the coming of distribution plants and with the metered selling of water, the water company has come to recognize the necessity for closer understanding between purveyor and customer.

Customer Attitude

To first understand the problem of creating good public relations between the water utility and consumers, we should first try to appreciate and understand the logic and the attitude of the average customer. I have met very few customers who have not thought that they were fully justified in complaining to the water company. I always make it a practice to handle all complaints coming to my attention with consideration and promptness. This, in my opinion, is the first step toward better public relations. It is hard to understand how easily a minor complaint may be turned into deep-seated resentment, if the complaint is not handled with a clear understanding and an unbiased attitude. Often a grievance so formed not only lasts indefinitely in the mind of the customer, but the customer often spreads ill-feeling against the company or the municipally owned utility, as the case may be.

The Author

Excessive Bills the Chief Problem

The greater number of complaints which we encounter are the result of excessive bills. Naturally our first impulse is to assume that if the water has not been legitimately used, a leak exists somewhere on the premises of the customer. The very first thing that we do, after the customer has laid his complaint before us, is to assure him that he certainly must have some concealed leak and that we will be glad to assist him in finding it. We explain to him the manner in which his meter is read and we stress the truth, that during our experience in the water business we have yet to discover a meter with over-registration. And, that barring an error in reading the meter (a possibility), his bill more likely represents something less than the amount of water that has passed through his meter since the last reading. I make it plain, too, that it is the policy of this company to make satisfactory adjustment whenever justified, and that his good will is worth more to us than the few dollars and cents that are involved. With just a little patience and personal attention such complaints are usually settled to the entire satisfaction of the customer—and to ourselves, we may add.

But how much better it is if the customer can be be given some warning of an excessive meter reading *before* he receives the bill. And this IS an important first step. It has been the policy of our company to keep an eye open for the coming of such complaints. This is done by systematically checking the route book (we have but one reader and one book) as it is brought in each day to note any abnormal meter recordings. We immediately follow through with a work order, using the account number for reference, which becomes a permanent record and is used for future reference, even years afterward. We state on this order the purpose for which the inspection of meter and premises is to be made. After the order has been worked it is returned to our desk. After reviewing it, a card with the following wording is mailed to our customer:

"A reading of your meter just taken shows that an unusually large amount of water has passed through your meter since the last reading, and if not actually used, indicates either waste or a leak. If it is the latter it will be a saving to you to have your plumber attend to it promptly. This company is not responsible after the water has passed through your meter and sends this notice to you as a courtesy.

Very respectfully,
(Signed)
Superintendent."

*A paper read before the 8th Annual Short School of the Georgia Water and Sewage Association.

Assistance in Locating Customer's Leaks

If our first inspection has definitely located the leak, we indicate its location on the margin of the card. This in most cases results in a double saving to the customer. This for the reason that when the plumber appears on the scene, the customer will have a definite job laid out for him and he will not spend unnecessary or dishonest time in locating the leak. The customer does not lose sight of such assistance on our part and it is most helpful to our future relations with this individual. We do not fail to stress the saving which we have been able to effect for him and our pleasure in doing so.

If we have not heard again from the customer before time to post the meter reading for his next bill we make another inspection in order to determine if the leak has been repaired. If it has been repaired, it is our policy to make an adjustment of the bill before it is sent out but we make it a point to let him know what we have done in regard to making the adjustment, and of the reason for our action. Ordinarily we have made a lasting friend—who may likely tell others of the treatment accorded him.

Meter Reading and Billing

The meter services are arranged in convenient routes. One man makes all the meter readings, taking a route each morning. Thus, by the 20th, allowing for two Sundays, the readings are completed and the bills are mailed so that the customer receives them the first of the following month.

It is easy to see the effect of informing the customer of a high consumption in advance of his bill, as it eliminates two high bills. Such is explained by the fact that we may be behind ten to thirty days in posting our bills after the meter reading has been taken. It is a very rare instance when we do not receive full co-operation in having leaks repaired.

The meter reader assists the cashier-bookkeeper in the afternoon in making up the bills, so that he knows the entire transaction. This creates a better understanding of the entire picture by the meter reader, so that he is in better position to talk more intelligently with the customer and can better answer questions and stop complaints.

A Venture in Newspaper Advertising

I wonder how many operators and superintendents who hear or read this paper have any appreciation of the part that newspaper advertising can play in your public relations. Our policy is to run two ads each month, one in the daily paper and one in the weekly paper, which are published in our town. Everybody in town reads these papers. I should like to give you a few examples of ads which we have had in our local papers:

"Water Waste Is Money Waste"

"Although Brunswick has one of the lowest water rates of any town in the country, comparable in size, it does not mean that water waste is not costly . . . Keep your plumbing in repair . . . We will assist you in locating leaks if you will call us. . . . A mere trickle running in 24 hours every day will mean an excess in your bill of 90 cents."

"Watch It"

"In these days when lawns need so much wetting, we recommend that you watch your sprinklers in order not to waste water. . . . We know that it is to our interest as well as yours that water consumption be maintained at an amount actually needed, without waste. . . . That is why we maintain such a careful check on water consumption and frequently call your attention to increased amounts used, due to leaks and wasteful methods—even before you are aware of it."

Fall and Winter Add to the Hazard of Fire

It is time to examine your homes, including chimneys and grates and be sure they are in good condition and safe for use. . . . See that chimneys are clean of soot. . . . Burning soot alighting on roofs frequently cause fires. . . . Aside from loss of property, the loss of life by fire is nearly 8,000 a year.

And, several years ago when we began chlorination of our supply, we had many complaints about taste and order. Here is an ad that we ran at that time that was very effective in reducing these complaints:

"Lost to a Great Cause"

"When Louis IX, King of France, sailed on his Second Crusade, no one had ever dreamed of CHLORINATION, now the universal protection for drinking water. Had it then been known, perhaps his army would not have experienced that sorry plight at Tunis sixty days later when more than half of his men were dead, and Louis himself succumbing to dysentery—a water-borne disease. . . . All untreated water is liable to infectious disease. . . . Be on the safe side—drink from Brunswick's public supply, which is CHLORINATED under supervision of the local and State Board of Health."

"Good Will"

. . . "The People's Water Service Company pledges its entire organization and facilities to the promotion and welfare of Brunswick and its people. . . . We seek your co-operation and covet the good will of all.

These ads were picked at random from our files, and have been accumulating for the past ten years. They have been most effective in creating good will on the part of our customers and the press—the last being of considerable importance.

Service With Courtesy

There is yet one essential consideration to which I wish to give passing comment. That is, SERVICE. Not service in terms of furnishing water that is pleasing to the taste—water without odor, or furnishing water at a desirable pressure. . . . Did you ever go into a store to make a purchase and not receive the courteous treatment to which you as a customer were entitled? You probably recall your reaction—no doubt leaving in disgust, never to return to the place again. Your dignity was wounded. . . . How well this might apply to a person that comes into your office to make application for service.

He expects and is entitled to immediate service. We all remember too well the times that we are asked "When can we get the water turned on?" and many times we are prone to be evasive and tell him that, "we'll get it on just as soon as possible." Then we have witnessed the satisfaction of a customer, when we tell him, "we'll have it on within the next hour."

Have our customers not the right to expect the same service that we ourselves expect, when we go into a store to buy a pair of shoes or an ice cream soda? I will say that they have. It will pay big dividends in better public relations, if we practice this thought.

In summing up this discussion, I should say that the fundamental point of public relations — the unknown quantity which we sell over our counter each day, is COURTESY. It costs us nothing except an understanding of the customers viewpoint and consideration of his personal rights. This is the one element that counts most in the sort of public relations you build.

at your Service

INSURES PALATABLE
NUCHAR
DRINKING WATER

When you order Aqua Nuchar you receive a product that is backed by over 25 years of constant research and technical development in activated carbons. For the past nine years Industrial Chemical Sales has concentrated its attention on the problems of water purification. Today, the service of our technical staff, who have acquired wide knowledge and experience in water plant taste and odor control, is at the disposal of any water official in need of advice or assistance without any obligation.

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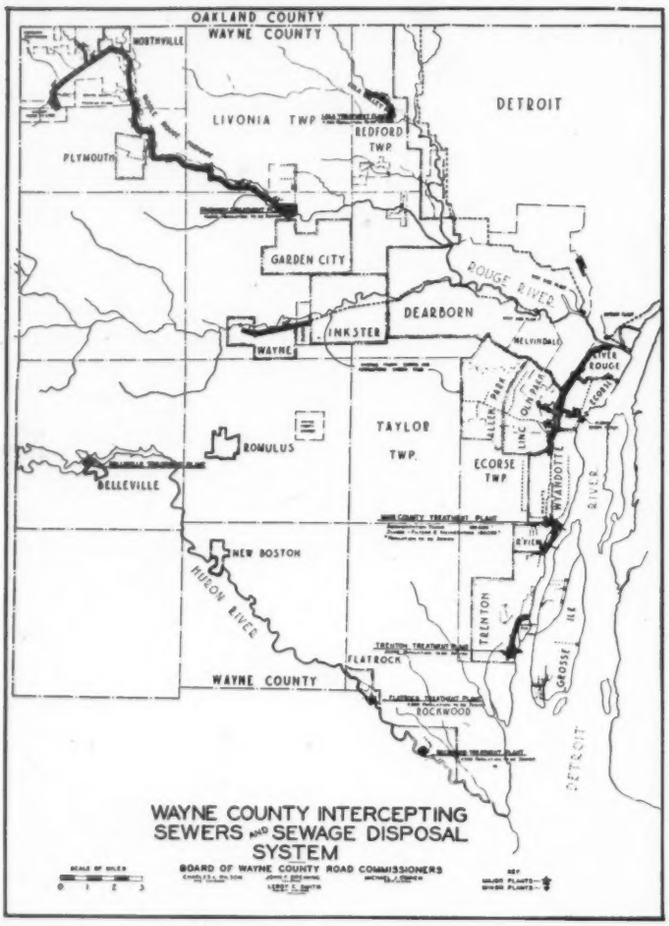
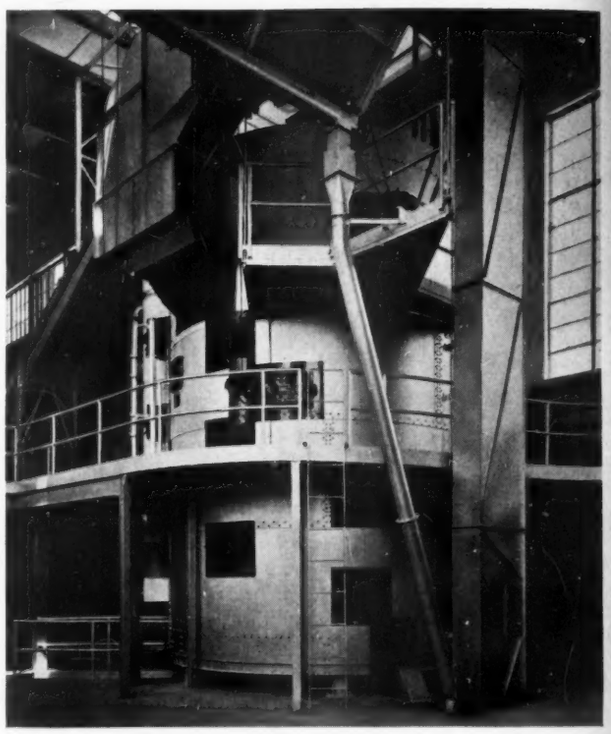
CLEVELAND, 417 Schofield Bldg.

WYANDOTTE Incineration Plant

serves 23 municipalities & communities in Wayne County, Michigan.





Right: View of 16'9" diameter, eight hearth Nichols Herreshoff Incinerator at Wyandotte

The entire Detroit and Wayne County area is now served by Nichols Herreshoff Incinerators at Wyandotte, Dearborn and Detroit.

The sewage from twenty-three municipalities in Wayne County, Michigan is treated in seven strategically located plants. Six of these are small plants without sludge disposal facilities. Stream-lined tank trucks carry liquid sludge and grit from these plants to the main plant at Wyandotte, where it is dewatered and burned to sterile ash in the eight hearth Nichols Herreshoff Incinerator.

Thus twenty-three localities are taking advantage of low cost centralized disposal of putrescible sewage sludge and grit in the most modern and scientific manner for the safeguarding of public health.

Any community interested in the sanitary disposal of municipal solid wastes—including sewage sludge, screenings, grit, garbage or rubbish should write "Incineration Headquarters" for the latest information and data. Bulletin No. 210 fully describes Nichols Herreshoff Incinerators.

NICHOLS

ENGINEERING & NERCO RESEARCH CORP.

60 WALL TOWER
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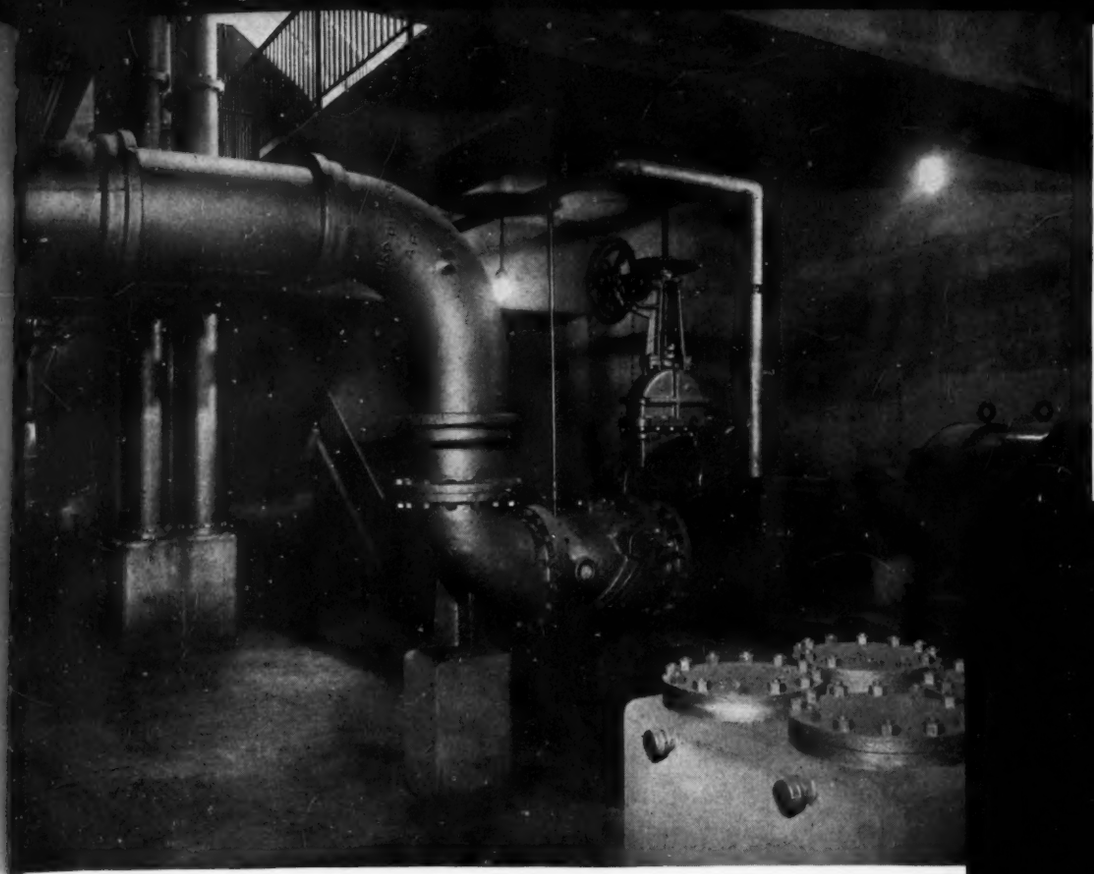


BALTIMORE, MARYLAND—
uses cast iron pipe in Back River Treatment Works.

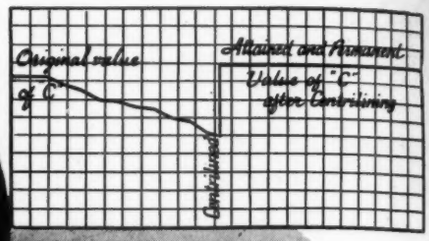
THE CAST IRON PIPE RESEARCH ASSOCIATION, THOMAS F. WOLFE, RESEARCH ENGINEER, 1015 PEOPLES GAS BUILDING, CHICAGO, ILLINOIS

CAST Q IRON

Look for the "Q-Check" registered trade mark. Cast iron pipe is made in diameters from 1¼ to 84 inches.

MIAMI BEACH, FLORIDA—
installs a cast iron force main and outfall for sewage disposal into the Atlantic.

THIS TUBERCULATED PIPE LINE

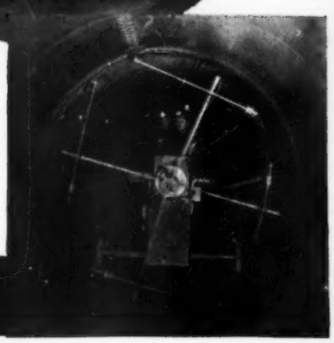


INTERIOR corrosion and tuberculation are two of the greatest sources of trouble in water-supply lines.

Centrilining your mains, whether steel or cast iron, permanently eliminates these two evils. This process consists of cleaning and then lining the pipe with cement mortar, by means of a specially designed centrifugal lining machine. It restores, and in many cases permanently increases the initial carrying capacity of the pipe line. The resultant savings in pumping costs plus the great reduction in depreciation costs, more than offset the investment.

Write us for information regarding the application of the Centriline Process to your pipe-line corrosion and tuberculation problems.

when *Centrilined* — will have its carrying capacity permanently restored



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- *Economical*
- *Permanent Results*

Centriline Corporation 140 Cedar Street, N. Y.

Centrilining not only restores but permanently protects

OMEGA—LAST WORD in CHEMICAL FEEDERS

SOME UP-TO-THE-MINUTE PLANTS USING OMEGA FEEDERS

New York City—Tallman's Island and Bowery Bay-Sewage
Cincinnati, Ohio—Water—Burns & McDonnell, Engrs.
Cleveland, Ohio—Sewage—Gascoigne & Assoc., Engrs.
Denver, Colo.—Sewage—Black & Veatch, Engrs.
Sandusky, Ohio—Water—Greeley & Hansen, Engrs.
Evansville, Ind.—Water—Alvord, Burdick & Howson, Engrs.
Atlanta, Ga.—Water—Paul Weir, Supt. Filtration
August, Ga.—Water—Robert & Co., Engrs.
Spartanburg, S. C.—Water—Wiedeman and Singleton, Engrs.
Detroit, Mich.—Water & Sewage—A. B. Morrill, Civil Engr.
Lansing, Mich.—Water—Claud Erickson, Engr.
Springfield, Ill.—Water—Chas. H. Spaulding, Supervising Chemist
Marion, Ind.—Sewage—Consoer, Townsend & Quinlan, Engrs.
St. Louis County Water Co., St. Louis, Mo.—W. V. Weir, Supt.
Ann Arbor, Mich.—Water—Ayres, Lewis, Norris & May, Engrs.
Topeka, Kans.—Water—Dan H. Rupp, Water Production Engr.
Lockport, N. Y.—Sewage—Shoecraft, Drury & McNamee, Engrs.
Dallas, Texas—Water—L. C. Billings, Supt. Filtration
Los Angeles, Calif. (Metropolitan Water Dist.)—Hoover & Montgomery, Consultants
Toronto, Canada—Water—Gore & Storrie, Engrs.

NOTE: In the above installations there are 75 Gravimetric Feeders and 9 Volumetric Feeders mounted on scales.

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HYDRAULICS IN CONNECTION WITH WATER AND SEWAGE WORKS*

A Discussion of Fundamental Principles Most Commonly Met With

By MARION L. CRIST, Engineer
Water Department
LITTLE ROCK, ARKANSAS

THE intent of this paper is to cover very briefly a few of the fundamental principles with which we most frequently come in contact in water works and sewerage practice, and to indicate the application of those principles.

First, let us consider an open body of water in which the liquid is at rest. By open we mean exposed to the atmosphere at the surface. The body of water may be a small vessel containing only a small amount of water, or it may be a huge lake.

What Constitutes Pressures

The pressure at any point in the body of water, referring to Figure 1, is dependent entirely upon the depth from the surface of the water to the point and the weight of the water, that is:

$$p = wh$$

where p = pressure in lbs. per sq. ft.
w = the weight of water in lbs per cubic ft.
h = the depth in feet.

The breadth and width of the vessel have nothing whatever to do with pressure. Neglecting differences in temperature, which affect the weight of water only slightly, the pressure 10′ deep in Lake Michigan is exactly the same as the pressure down 10′ from the top of a ½″ pipe standing on end and filled with water. Or again the pressure at the bottom of a standpipe 2′ in diameter and 100′ high is exactly the same as the pressure at the bottom of the standpipe for an elevated tank, of the same height, even though the tank itself may be 50′ in diameter.

Actually the pressure at any point X in Figure 1 is the weight of the column of water above that point. The pressure in pounds per square inch being the weight of a column 1″ square and of height "H" or the pressure in pounds per square foot being the weight of a column 1′ square and of height "H."

From this simple relationship it is always possible to compute the pressure in pounds per square inch corresponding to a column of water of given height. Suppose that we have an elevated tank in which the water stands 120′ above the ground. Since water weighs 62.5 pounds per cubic foot, the pressure at the ground is $120 \times 62.5 = 7{,}500$ lbs. per square foot. Converting to pounds per square inch $\frac{7{,}500}{144 \text{ (sq. in.)}} = 52.08$ pounds per square inch.

The Author

It is also important to remember that pressures in confined liquids are equal in all directions. Horizontal pressures are exactly equal to vertical pressures. Therefore, the horizontal pressure against the sides of a vessel at any depth can be computed in the above manner. For instance at the 120 ft. depth the pressure against the side walls of a vessel is the same 52.08 lbs./sq. in.

Since horizontal dimensions have *nothing* to do with pressure the force acting against a dam, for instance, is entirely independent of the length of the lake. The pressure per foot of length of a dam 100′ high is exactly the same whether the lake be 100′ long or 100 miles long. Therefore, it takes just as strong a dam to impound the small lake as it does to impound the large one.

Pressure of Water in Motion

So far we have been discussing water at rest. Now let us consider moving water, that is, the principles of hydrodynamics. Again we are interested in pressures but in addition velocities, friction losses, and carrying capacities become important.

In order to get water into motion energy must be expended and the head required to produce a certain velocity is:

$$h = \frac{V^2}{2g}$$

where h = the head in feet
V = the velocity in feet per second
g = the acceleration of gravity in feet per second = 32.2

This "h" is actually the kinetic energy per pound of water due to a velocity of "V" feet per second, but it is much simpler to think of it as the head required to get the water into motion at that speed or if you prefer the head which would be recovered if the velocity were instantaneously stopped. It is called the "velocity head."

Let us consider the flow of water through the pipe and between the vessels shown in Figure 2. The total head causing flow is the difference in elevation of the two water surfaces, "H." We know that the greater this head "H" the greater the flow from vessel A to vessel B, but let us consider why this is true and what becomes of the head.

First, in order to get the water under way in the pipe at all, some of the head must be expended in creating velocity. Then, as the water flows through the pipe, there is constant friction between the pipe walls and the water as well as internal friction between the particles of water themselves, all of which requires energy and uses up some of the head "H." Finally, as the water passes through the ell, the gate valve, and the check valve, additional losses occur which use up more of "H." When the rate of flow becomes such that the sum of all of these losses is exactly equal to "H" then a condition of equilibrium obtains and that quantity of water will continue to flow as long as the head "H" remains unchanged and the friction losses are constant.

*A paper and discussion presented before the 1940 Arkansas Water and Sewage Conference.

Table 1 shows the loss in standard cast iron fittings and valves in terms of fractions of a velocity head. These losses were determined by the American and the New England Water Works Associations.

Even though from the table of losses we know that the exist loss is greater than the entrance loss you will notice that the gradient as drawn in Figure 2 indicates a considerable drop at A and a slight rise in gradient at B. The reason for this is that in addition to the 0.5 of one velocity head loss in the entrance at A, there is also one full velocity head expended in getting the water into motion in the pipe. Thus the actual drop at A is 1.5 velocity heads. At B, on the other hand, there is 0.9 of one velocity head loss in the exit, but one whole velocity head is recovered when the pipe velocity is stopped in vessel B. Thus the recovery of head is $0.1 \times \frac{V^2}{2g}$ greater than the loss and there will actually be a slight rise in the gradient entering vessel B.

TABLE 1.

Loss of Head in Fittings, etc., in Terms of Velocity Head

Fitting	Loss Fraction of $\frac{V^2}{2g}$	
1′ to 6′ Rad. 90° Bends	0.25	
1′ to 6′ Rad. 45° Bends	0.20	
1′ to 6′ Rad. 22½° Bends	0.13	
Tees	1.25	
Wyes	1.00	
Reducers (Vel. at small end)	0.25	$\left(\frac{V1^2}{2g} - \frac{V2^2}{2g}\right)$
Increasers	0.25	
Bell Mouthed Reducer	0.10	
Entrance to Pipe from Well	0.50	$\left(\frac{V1^2}{2g} - \frac{V2^2}{2g}\right)$
Entrance to Well from Pipe	0.90	
Wide Open Shear Gate (Orifice)	1.80	
Wide Open Sluice Gates in Walls 12″ thick (submerged)	2.35	
Wide Open Gate Valve	0.10	
Wide Open Globe Valve	2.00	
Passing Branches or other Openings	0.03	
Foot Valve	1.50	(doubtful)
Check Valve	0.50	(doubtful)
Hose Nozzle	0.07	
2½″ Hydrant Nozzle	1.00	
Corey Hydrant (overall)	.01	(V at butt)

From this table the losses in Figure 2 at the entrance, the exit, the fitting, and the valves can be determined in terms of velocity head as follows:

	$\frac{V^2}{2g}$
Entrance Loss	0.50
Exit Loss	0.90 "
Loss in Ell	0.25 "
Loss in Gate Valve	0.10 "
Loss in Check Valve	0.50 "
Total Loss Exclusive of Pipe Friction	2.25

Meaning of Hydraulic Gradient

We are now in position to draw an approximate hydraulic gradient between vessel A and vessel B. The hydraulic gradient is a line the vertical distances to which shows the pressure heads at the different points in the pipe system, or it can be defined as the line to which water would rise in small tubes placed at intervals along the line.

In Figure 2 there is a slight drop in gradient at the entrance, first, in order to get the water into motion and, second, by reason of entrance losses. The gradient then slopes gently down, by reason of friction in the pipe, to the ell where there is another drop because of friction in the ell. Then the gradient slopes on through the gate and the check, with a slight drop in each, to vessel B where there is another drop by reason of exit losses and a rise by reason of recovered velocity. The gradient would, of course, begin at the water surface at A and end at the water surface at B.

In order to illustrate the actual determination of these various losses and of the flow which might be expected from vessel A to vessel B, in Figure 2, let us assume that "H" is 25′ and that the total length of 6″ pipe connecting the two vessels is 150′.

The Well-Known Williams-Hazen Formula for Determining Friction Loss

The friction loss in pipe varies greatly with the roughness of the pipe. Perhaps the most commonly accepted formula for determining the velocity in pipes is that developed by G. S. Williams and Allen Hazen known as the Williams-Hazen formula. This formula is:

$$V = C\, r^{0.63}\, S^{0.54}\, 0.001^{-0.04}$$

where V = velocity in feet per second
r = hydraulic radius of the pipe
S = hydraulic slope in feet per foot
C = a constant, dependent upon the roughness of the pipe

At first glance this formula ap-

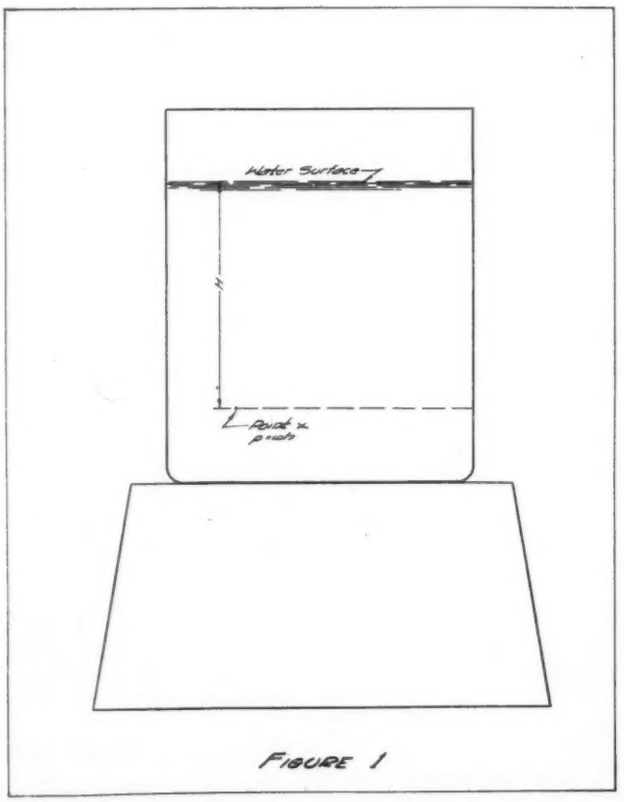

Fig. 1—Diagram Explaining Head and Pressure.

pears rather complicated, but its use has been greatly simplified by the preparation of tables which solve the formula for different pipe sizes, different slopes, and different coefficients. Therefore, in order to solve our problem it becomes necessary only to compute the hydraulic slope and to assume a value of "C."

"C" in new cast iron pipe will vary between 120 and 140, but after the pipe has been in service for some time the coefficient may drop to 100 or below. In the present case let us assume a coefficient of 120.

For the first trial solution let us neglect the losses in fittings, etc., in order to determine roughly the nature of the velocity to be encountered. Upon this basis this slope "S" becomes the total head "H" divided by the total length of pipe.

$$S = \frac{25}{150} = .1667 \text{ ft./ft.}$$

The Williams-Hazen tables then tell us that a 6" pipe with a coefficient of 120 and a slope of .1667 will deliver approximately 2,100,000 gallons per day and the velocity through the pipe will be approximately 16′ per second, one velocity head at this velocity being 3.98′.

This indicates that losses through the fittings are appreciable and will reduce the discharge materially. Therefore, they must be taken into consideration. If in the problem at hand a velocity head of 3.98′ is to occur then the loss in entrance, fittings, valves, and exit would amount to 3.98 × 2.25 = 8.95 feet, leaving only 16.05′ of our total of 25′ to account for pipe friction loss. This would reduce the hydraulic slope "S" from .1667 feet per foot to .107 feet per foot, and the Williams-Hazen tables tell us that a 6" pipe with a "C" of 120 on this slope will deliver approximately 1,625,000 gallons per day, and that the velocity under these conditions is 12.81′ per second, making the velocity head 2.55′.

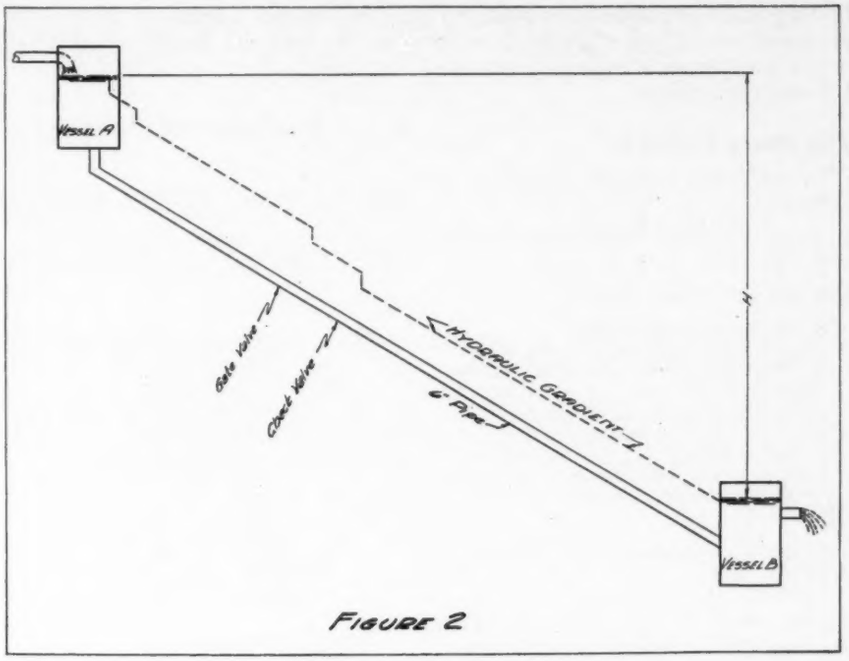

FIGURE 2

Fig. 2—Sketch Explaining Hydraulic Gradient

Thus the actual discharge of the pipe in Figure 2 lies between 1,625,000 and 2,100,000 gallons per day, the velocity between 12.81 and 16 feet per second and the velocity head between 2.55 and 3.98 feet. By the method of trial and error the actual discharge, velocity, and velocity head can now be determined.

For example let us assume a discharge of 1,750,000 gallons per day. The velocity will equal 13.82′ per second and the velocity head will equal 2.96′. The loss per foot of 6" pipe at the discharge with a "C" of 120 is .123′ per foot. The total losses are shown below.

Thus the actual flow through the pipe in Figure 2 will be approximately 1,750,000 gallons per day. The losses in each of the fittings, valves, etc., will be the proper fraction of the velocity head, which is 2.96′.

These same principles apply to pipe of all sizes and description. Understanding of them and their proper application will prevent unnecessarily large piping installations as well as installations which prove to be too small to serve their intended purpose.

Pipe Friction Losses	$.123 \times 150 = 18.45$
Other Losses	$2.25 \frac{V^2}{2g} = 2.96 \times 2.25 = 6.66$
Total Loss	$= 25.11$ feet

DISCUSSION

By EDWARD R. STAPLEY, Professor of Sanitary Engineering
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Since, as has been explained, it is a customary practice to express special losses in pipe lines, such as those at entrance and exit, and at various fittings and valves, in terms of the velocity head in the line, it will also make the calculations simpler if we express the loss due to pipe friction in a similar manner. We then have the sum of all of the losses expressed in terms of $\frac{V^2}{2g}$, or as so many velocity heads. If this is then set equal to the total available head, we can solve for the velocity readily. Such a procedure eliminates the necessity of solution by trial where close approximations are sufficiently accurate for practical purposes. This method is also valuable for the man in the field who may have to make his calculations without the aid of tables

or diagrams. The back of an old letter or paper from one's pocket and a pencil are the only materials needed for the calculations.

The Darcy Formula

In the Darcy formula, where $h = f \frac{l}{d} \frac{V^2}{2g}$, we have an expression suitable for our needs. Here

h = the loss of head in feet,
f = a friction coefficient, varying with the velocity, and the diameter and type of pipe.
l = the length of the pipe in feet,
d = the diameter of the pipe *in feet*,
V = the velocity in feet per second, and
g = the acceleration of gravity (32.2 feet per second per second).

Since $\frac{l}{d}$ represents the length of pipe in terms of the diameter, or as we say the number of diameter-lengths of pipe, if we insert a value of f we shall then have the loss of head in the pipe line, due to friction, expressed in terms of $\frac{V^2}{2g}$. For the loss of head, h, to equal one $\frac{V^2}{2g}$ (one velocity-head), $f \frac{l}{d}$ in the formula must equal 1. Now if f is taken to have an average value of 0.025, then $\frac{l}{d} = \frac{1}{0.025} = 40$. This is equivalent to saying that 40 diameter-lengths of this pipe will give one $\frac{V^2}{2g}$ loss of head due to friction.

In the problem assumed, the length of pipe is 150 feet and the diameter 6 inches. The value of $\frac{l}{d}$ would then be $\frac{150}{0.5} = 300$, or 300 diameter-lengths of pipe. Since 40 diameter-lengths of pipe are required to give one $\frac{V^2}{2g}$ loss of head, then 300 diameter-lengths will give $\frac{300}{40} = 7.5$, or $7.5 \frac{V^2}{2g}$ loss. If this is added to the $2.25 \frac{V^2}{2g}$ previously calculated for the special losses at entrance, in fittings, etc., we have a total loss of $2.25 \frac{V^2}{2g} + 7.5 \frac{V^2}{2g}$ or $9.75 \frac{V^2}{2g}$. Setting this equal to the 25 feet of total head available in the problem, we can solve for the velocity as shown below.

$$9.75 \frac{V^2}{2g} = 25$$

$$V^2 = \frac{25 \times 64.4}{9.75} = 165.1$$

$\therefore V = 12.9$ feet per second

The discharge, Q = Area of Pipe x Velocity $= \frac{\pi d^2}{4} \times V$

$= \frac{\pi (0.5)^2}{4} \times 12.9 = 2.53$ cubic feet per second

1 cubic foot per second equals approximately 646,000 gallons per day.

Therefore, we have $2.53 \times 646{,}000 = 1{,}634{,}000$ gallons per day as the discharge with the assumed value of the friction factor, f.

The value of f has been stated to vary somewhat with the velocity, and diameter and type of pipe. In this particular problem the value of 0.025 taken for f would correspond to a value of about 110 for the Williams-Hazen "C." Since the pipe in the problem was assumed to have a value of 120 for "C," the discharge of 1,634,000 gallons per day, as just calculated, should be corrected by dividing it by 110 and multiplying by 120. The final discharge, with C = 120, would then be $1{,}634{,}000 \times \frac{120}{110} =$ 1,780,000 gallons per day. This value is seen to check very closely the value obtained by the use of a diagram or the Williams-Hazen tables.

For rough calculations, the value of 40 diameter-lengths of pipe for one $\frac{V^2}{2g}$ loss could be remembered as being approximately equivalent to C = 100. The discharge so obtained could then be easily multiplied in one's head by the ratio of the estimated value of "C" for the pipe in question to 100. For example, with a rather new smooth surface pipe, estimated to have a value of C = 140, we would multiply by 1.4 our approximate discharge calculated.

Attacking a problem from this angle, also brings out the relative effect of the special losses at entrance, exit, and in fittings, as compared to the loss due to pipe friction. In the problem here assumed, these special losses amounted to $\frac{2.25}{9.75} = 0.231 =$ 23%, or almost one-fourth of the total loss in the system. While, if our line had consisted of 1,000 feet of 6-inch pipe (instead of the 150 feet assumed in the problem), $\frac{l}{d}$ would have been $\frac{1{,}000}{0.5} = 2{,}000$ and $\frac{2{,}000}{40}$ would have been 50, or $50 \frac{V^2}{2g}$ loss of head due to pipe friction. Compared to this, the $2.25 \frac{V^2}{2g}$ loss in fittings and at entrance and exit, would be $\frac{2.25}{52.25} = 0.043 =$ 4.3%, a relatively unimportant item and one which could be neglected for all practical purposes. This same relative effect would also be shown if the various special losses were reduced to equivalent lengths of straight pipe to be added to the actual pipe length, as is sometimes done, and the sum of these equivalent lengths compared to the actual length of pipe used.

Coal Shipments by Pipe Line?

Shipment of coal by pipe-line may eventually become a commercial reality.

A patent has been issued on a process for converting the coal into a form suitable for piping. Full details of the process have not been made public, but it consists, in general, in grinding the coal into fine particles and suspending it in water with the aid of certain chemicals.

No actual long-distance tests have been made on the method, but it is said that there appear to be no technical obstacles to its success. If the process attains commercial use, it will permit the economical tapping of deposits that are now inaccessible.

FIRE HYDRANT FLOW TESTS

A Discussion

By HENRY E. NUNN, Eng'r. and Sup't.
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VAN BUREN, ARKANSAS

MR. CRIST has given us some practical examples of the meaning of the commonly referred to "Hydraulic Gradient" and other terminology in hydraulics more commonly used in water works and sewerage practices. He has explained the significance of friction losses in pipe lines and how to compute these, and he has explained the steps to take in determining the capacity of an existing pipe line; also how to determine the proper size of pipe line to give a required flow under conditions existing or to be created. I shall attempt to explain the hydraulic principles involved in making the important "Fire Hydrant Flow Test."

In operating a water system it is important to know how much water the mains can supply in the way of fire demand at the hydrants. Flow tests applied to the hydrants are the accepted method of securing such information. In making these tests weak places in the system will be revealed. Valves closed or partly closed, unknown to the superintendent, will be spotted and this dangerous condition corrected. The existence of mains that need to be cleaned, or to be replaced by larger mains will be detected. Further, these tests will help in planning extensions and feeder lines, or elevated storage, to strengthen the system, or the looping of dead ended mains to improve service flow as well as fire flow.

There are many other advantages in having a record of hydrant flow tests before the superintendent and later, the governing body. The primary reason for such tests, however, is that of learning the dependable fire stream capacity of old mains and the need to strengthen the weak sections of the system by correcting whatever the defects may be.

It may be said that fire hydrant flow tests should be scheduled as almost a routine practice. It is the only sure method of keeping tabs on the condition of the system and where the depreciation rate stands from year to year.

The Author

Making the Test and Computations Required

In making hydrant flow tests the equipment needed is a Piezometer and a tapped nozzle cap with a pressure gauge inserted.

Mr. Crist gave us the formula:

$$P = WH$$

Where P = pressure in pounds per square foot
W = weight of water in pounds per cubic foot = 62.5 lbs.
H = head of water in feet

The pressure gauges are graduated in pounds per square inch, so it is necessary to get the relationship between the head in feet and the pressure in pounds per square inch.

$P = WH$
$P = 62.5H$ in lbs. per sq. ft.
$P = \frac{62.5 \times H}{144} = .434H$ in lbs. per square inch, or
$H = 2.31P$

The other formula which Mr. Crist used is:

$$H = \frac{V^2}{2GH} \qquad \text{or, } V = \sqrt{2GH}$$

In this formula:
H = the head in feet
V = the velocity in feet per second
G = the acceleration of gravity in feet per second; per second = 32.2 under all conditions.

The formula for the discharge of water is:

$$Q = AV$$

Q = the discharge in cubic feet per second
A = the area of the pipe or opening in square feet
V = the velocity in feet per second, as above.

An Example of Computations

Let us consider the computations for a fire hydrant where we have found the static pressure (reading of gauge in nozzle cap with pressure on and no flow through the hydrant) to be 60 pounds per square inch, the nozzle pressure (reading of piezometer or Pitot gauge held in the discharging stream from the nozzle) to be 25 pounds per square inch, and the diameter of the nozzle to be 2½ inches. [Note—The nozzle diameter must be measured exactly, as a check in making these tests. If the size is only slightly different from that assumed a large error may result in the flow figure computed.]

Using the formula:

$V = \sqrt{2GH}$
Convert pressure into head—
P = 25 pounds per sq. in. (from Piezometer or Pitot)
$H = 2.31 \times 25 = 57.75$ ft.—then
$V = \sqrt{2 \times 32.2 \times 57.75} = \sqrt{3719.1}$
V = 60.9 feet per second

Using the formula:

$Q = AV$
$A = \pi r^2$
$A = 3.1416 \times (2.5 \times 2.5) = 4.91$ sq. in.
(Converted to square ft. $\frac{4.91}{144} = 0.0341$ sq. ft.) and
$Q = 0.341 \times 60.9 = 2.07$ cubic feet per second.

But some allowance must be made for roughness of edges of opening and in consequence a correcting coefficient of .90 is applied. And—

$2.07 \times .90 = 1.86$ cubic feet per second is the actual discharge.
Since 1 cubic foot = 7.5 gallons
$1.86 \times 7.5 = 13.95$ gallons per second
$13.95 \times 60 = 837$ gallons per minute (the answer).

For all practical purposes we can record the output of this hydrant as 840 GPM.

A Less Involved Formula

Another, and less involved, formula which may be employed with fewer side computations is:

$$Q = (29.83 \times C) \times (D^2 \times \sqrt{P})$$

In this formula:
Q = discharge in gals./min. direct
P = pressure as observed—i.e., lbs./sq. in. gage reading
D = nozzle diameter (checked by measurement)
C = roughness coefficient of nozzle (0.90)

Condensed, this formula becomes for all practical purposes:

$$Q = 27 \times D^2 \times \sqrt{P}$$

TABLE 1—HYDRANT DISCHARGE

Gallons per minute = $27\,d^2\sqrt{p}$*

Gage Reading—Hose nozzle diameter in inches [d]						
p	2 5/16	2⅜	2 7/16	2½	2 9/16	2⅝
¼	70	80	80	80	90	90
½	100	110	110	120	120	130
¾	120	130	140	150	150	160
1	140	150	160	170	180	190
1¼	160	170	180	190	200	210
1½	180	190	200	210	220	230
1¾	190	200	210	220	230	250
2	200	210	230	240	250	260
2½	230	240	250	270	280	290
3	250	260	280	290	310	320
3½	270	280	300	320	330	350
4	290	300	320	340	350	370
4½	310	320	340	360	380	390
5	320	340	360	380	400	420
5½	340	360	380	400	420	440
6	350	370	390	410	430	460
6½	370	390	410	430	450	470
7	380	400	420	450	470	490
7½	400	420	440	460	490	510
8	410	430	450	480	500	530
8½	420	440	470	490	520	540
9	430	460	480	510	530	560
9½	440	470	490	520	550	570
10	460	480	510	530	560	590
11	480	510	530	560	590	620
12	500	530	560	590	610	650
13	520	550	580	610	640	670
14	540	570	600	630	660	700
15	560	590	620	650	690	720
16	580	610	640	670	710	740
17	600	630	660	700	730	770
18	610	650	680	720	750	790
19	630	660	700	740	770	810
20	640	680	720	750	790	830
22	680	710	750	790	830	870
24	710	750	790	830	870	910
26	740	780	820	860	900	950
28	760	810	850	890	940	980
30	790	830	880	920	970	1020

*Discharges shown to nearest 10 gals. per min.

It will be seen that since the table shows flows to the nearest 10 GPM only that the 845 GPM figure is adequate for the purpose. The figure from the graph checks the involved computation within 3 GPM.

Use of the Findings

The maximum hydrant output revealed in this test is therefore 840 GPM and represents the full main capacity for the existing pressure on it at the time of test.

This yield may then be dated and put on record. A later test will reveal any further falling off of main capacity and, therefore the rate of depreciation may be detected. If the main is cleaned the subsequent test will reveal the extent of improvement in main delivery to the hydrants. Or the benefit from elevated storage will be revealed if such is secured as a betterment.

In this regard yields obtained should be compared with recommendations of the National Board of Fire Underwriters, and the State Authority, pertaining to acceptable fire flows for various sized communities, and districts of various classifications therein. In this direction the accompanying fire stream tables (also taken from the 1940 Reference and Data Number of WATER WORKS AND SEWERAGE) should prove of value.

Tables and Graphs Save Computations

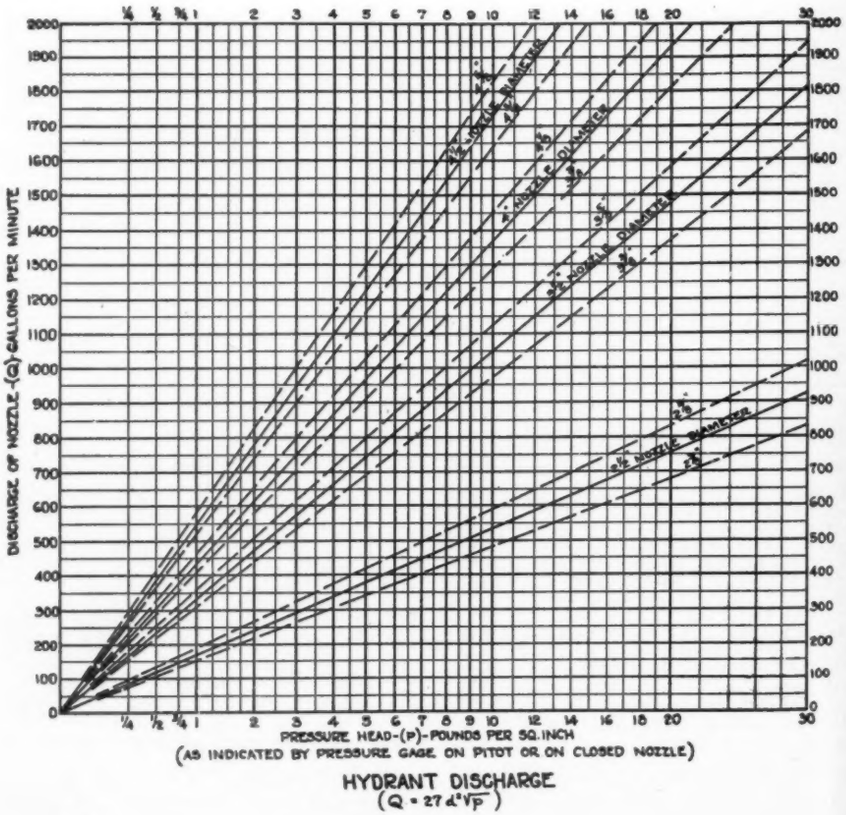
It is no longer necessary to make these tedious computations, because tables and graphs have been developed by engineers and published for the benefit of operators who undertake to make such hydrant flow tests.

Such a table and a graph, based on the above formula, is presented here. These were taken from the Reference and Data Section of the April, 1940, issue of WATER WORKS AND SEWERAGE. They appear with a very complete article by P. S. Wilson which gives details pertaining to the making of such flow tests. With it there is a discussion of what is revealed in the findings and the indicated corrections.

Referring to this table and graph the problems used as an example above becomes simple.

Locating the pressure of 25 lbs./sq. in. (as read), and then the 2.5 in. nozzle diameter, the results are:

Table = 845 GPM
Graph = 840 GPM


DISCHARGE OF NOZZLE-(Q)-GALLONS PER MINUTE
PRESSURE HEAD-(P)-POUNDS PER SQ. INCH
(AS INDICATED BY PRESSURE GAGE ON PITOT OR ON CLOSED NOZZLE)
HYDRANT DISCHARGE
(Q = 27 d² √P)

Fire Flows Required for Towns of Various Sizes, by National Board of Underwriters

Population	Required Fire Flow, Gallons per Minute for Average City
1,000	1,000
2,000	1,500
4,000	2,000
6,000	2,500
10,000	3,000
13,000	3,500
17,000	4,000
22,000	4,500
28,000	5,000
40,000	6,000
60,000	7,000
80,000	8,000
100,000	9,000
125,000	10,000
150,000	11,000
200,000	12,000

Over 200,000 population, 12,000 gallons a minute, with 2,000 to 8,000 gallons additional for a second fire.

In residential districts the required fire flow depends upon the character and congestion of the buildings. Sections where buildings are small and of low height and with about one-third the lots in a block built upon, require not less than 500 gallons a minute; with larger or higher buildings up to 1,000 gallons is required, and where the district is closely built, or buildings approach the dimension of hotels or high value residences, 1,500 to 3,000 gallons is required, with up to 6,000 gallons in densely built sections of 3-story buildings.

Commercial Pipe Sizes for Fire Streams*

Number of 1 ½-Inch Hose Nozzles	Ordinary Fire Streams											
	40 Pounds Pressure		50 Pounds Pressure		60 Pounds Pressure		70 Pounds Pressure		80 Pounds Pressure		90 Pounds Pressure	
	Required Size Pipe Ins.	Flow Cu. Ft. per Min.	Required Size Pipe Ins.	Flow Cu. Ft. per Min.	Required Size Pipe Ins.	Flow Cu. Ft. per Min.	Required Size Pipe Ins.	Flow Cu. Ft. per Min.	Required Size Pipe Ins.	Flow Cu. Ft. per Min.	Required Size Pipe Ins.	Flow Cu. Ft. per Min.
1	4	20	6	23	6	25	6	27	6	29	6	30
2	6	40	8	45	8	50	8	53	8	57	8	61
3	8	61	8	68	10	74	10	80	10	86	10	91
4	10	81	10	90	10	99	10	107	12	114	12	121
5	10	101	12	113	12	124	12	134	12	143	12	152
6	12	121	12	135	12	149	14	160	14	172	14	182
7	12	141	14	158	14	174	14	187	14	200	16	212
8	12	162	14	181	14	199	16	214	16	229	16	242
9	14	182	14	203	16	223	16	241	16	257	18	273
10	14	202	16	226	16	248	16	267	18	286	18	303
11	16	222	16	248	18	273	18	294	18	314	18	333
12	16	243	18	271	18	298	18	321	20	343	20	364
13	16	263	18	293	18	323	20	348	20	372	20	394
14	18	283	18	316	20	348	20	374	20	400	20	424
15	18	303	20	339	20	372	20	401	20	429	24	455
	High-Pressure Fire Streams											
	100 Pounds Pressure		110 Pounds Pressure		120 Pounds Pressure		130 Pounds Pressure		140 Pounds Pressure		150 Pounds Pressure	
1	6	32	6	33	6	35	6	36	6	38	6	39
2	8	64	8	67	10	70	10	73	10	75	10	78
3	10	96	10	100	10	105	10	109	12	113	12	117
4	12	128	12	134	12	140	12	145	12	151	14	156
5	14	160	14	167	14	174	14	181	14	188	14	195
6	14	191	14	200	14	209	16	218	16	226	16	234
7	16	223	16	234	16	244	16	254	16	264	18	273
8	16	255	16	267	18	279	18	290	18	301	18	313
9	18	287	18	301	18	314	18	326	18	339	20	352
10	18	319	18	334	20	349	20	363	20	377	20	391
11	20	351	20	367	20	384	20	399	20	414	20	430
12	20	383	20	401	20	419	20	435	24	452	24	469
13	20	415	20	424	24	454	24	472	24	490	24	508
14	24	447	24	467	24	488	24	508	24	528	24	547
15	24	479	24	501	24	523	24	544	24	565	24	586

To convert cubic feet to gallons, multiply by 7.4805.
In calculating above table, the following assumptions were made: Nozzles, 1 ½-inch smooth bore, playing simultaneously, and attached to 200 feet of best quality rubber-lined hose; pressures measured at hose connections; velocity of water in pipe approximately 3 feet per second.

TABLE OF EFFECTIVE FIRE STREAMS

Using 100 feet of 2½-in. ordinary best quality rubber-lined hose between nozzle and hydrant or pump.

Smooth Nozzle, Size	¾ Inch						⅞ inch				
Pressure at Hydrants, lbs.	32	43	54	65	75	86	34	46	57	69	80
Pressure at Nozzle, lbs.	30	40	50	60	70	80	30	40	50	60	70
Press. lost 100′ 2½″ hose	2	3	4	5	5	6	4	6	7	9	10
Vertical Height, feet	48	60	67	72	76	79	49	62	71	77	81
Horizontal Distance, feet	37	44	50	54	58	62	42	49	55	61	66
Gallons Discharged per min.	90	100	116	127	137	147	123	142	159	174	188

Smooth Nozzle, Size	1 Inch						1¼ Inch				
Pressure at Hydrant, lbs.	37	50	62	73	85	97	41	54	67	80	93
Pressure at Nozzle, lbs.	30	40	50	60	70	80	30	40	50	60	70
Press. lost 100′ 2½″ hose	7	10	12	13	15	17	11	14	17	20	23
Vertical Height, feet	51	64	73	79	85	89	52	65	75	83	88
Horizontal Distance, feet	47	55	61	67	72	76	50	59	66	72	77
Gallons Discharged per min.	161	186	208	228	246	263	206	238	266	291	314

Smooth Nozzle, Size	1¼ Inch						1⅜ Inch				
Pressure at Hydrant, lbs.	46	60	75	90	104	119	52	69	86	102	119
Pressure at Nozzle, lbs.	30	40	50	60	70	80	30	40	50	60	70
Press. lost per 100′ 2½″ hose	16	20	25	30	34	39	22	29	36	42	49
Vertical Height, feet	53	67	77	85	91	95	55	69	79	87	92
Horizontal Distance, feet	54	63	70	76	81	85	56	66	73	79	84
Gallons Discharged per min.	253	292	326	357	386	413	307	354	396	434	469

Long Island Section of N. Y. State Sewage Ass'n. Holds Summer Outing Way Out on Timber Point

While luncheon is on, glamorous Mona Cordell, from the Tallmans Island N. Y. City Plant Laboratory, does some fancy diving. (3) As usual fiscal matters must be attended to and Larry Luther (Secretary) is at the same old stand. (4) "Herb" Johnson of Belgrave Sewer District and Frank Holland, Freeport's Commissioner

ROTARY BLOWERS IN ACTIVATED SLUDGE PLANTS*

By D. L. DOWLING

NEW YORK, N. Y.

OF the uses for medium pressure air in sewage disposal plants, the aeration of raw sewage mixed with sludge in the activated sludge process is the most important one. Other air uses include grease separation, sludge lifting, mixing in chemical treatments, and preventing solids from stranding in channels.

In the activated sludge process the method of compressing the air, the economy of installation and operation, and the flexibility of the plant are of prime importance.

The air is introduced under 5 to 8 lbs. pressure, usually at the bottom of the aeration tank, through porous plates or tubes. Approximately ½ to 1½ cu. ft. of air are required per gallon of sewage, and large volumes of air and power are involved in the larger plants. For instance, the Wards Island Plant of New York City has an installed blower capacity of 227,000 CFM and 12,000 HP.

For supplying air all kinds of compressors have been tried, including reciprocating, sliding vane, liquid piston type, etc., but now in nearly 100% of the installations in this country and Canada the blowers are either of the rotary positive or centrifugal types.

Rotary Blowers

The term "rotary positive," as distinguished from "centrifugal," denotes a machine in which two conjugate lobed impellers operate within a case with close clearances but without internal contact and without internal lubrication or seal. The rotary positive blower is a simple mechanical device. It has two moving parts operating in rotary motion at moderate speed without contact. Its characteristics are equally simple, approximating those of a reciprocating compressor.

Rotary two impeller type blowers have been manufactured by the Roots-Connersville Blower Corporation and its predecessors since 1854. This company also manufactures centrifugal blowers for use in sewage disposal plants, but this paper is concerned only with the rotary positive type and its application to activated sludge plants.

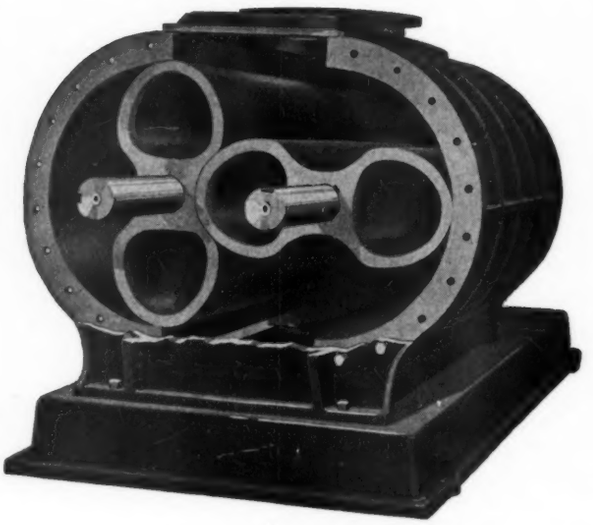


Fig. 1—Cross Section of Typical Blower of Roots Type

Fig. 1 shows a cross-section through the case of a typical "Roots" type blower. The figure-eight shaped impellers with conjugate curves operate in opposite directions of rotation. Fig. 2 shows the impellers in four different positions and indicates how the air is trapped and swept around the case. This diagram shows bottom discharge although sewage plant blowers and most others are installed for top discharge. The shaded portions indicate air at the low pressure and the unshaded portions air which has been compressed. The relative angular position of the impellers is maintained by a pair of gears on the impeller shafts, mounted external to the case and also serving to transmit the drive power from the connected

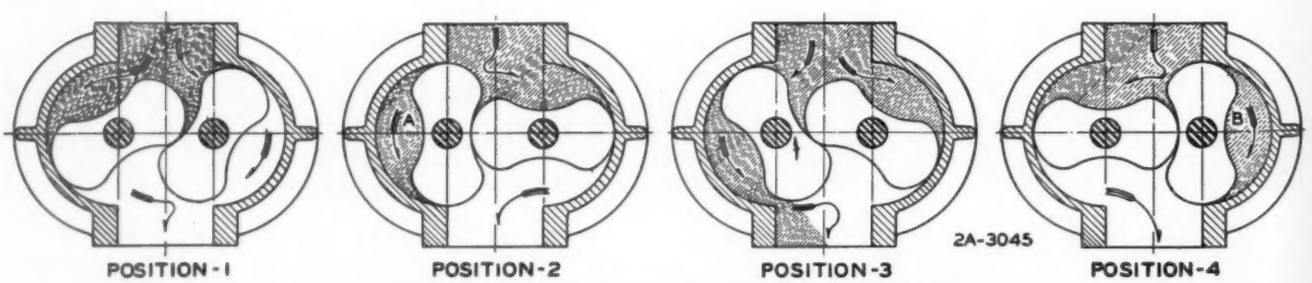


Fig. 2—Blower Impellers in Four Successive Positions

* A paper presented before the Sanitation Section, American Society of Mechanical Engineers, in New York City.

† District Manager, New York Office, Roots-Connersville Blower Corp. of Connersville, Ind.

shaft to the free shaft. Four "pockets" of air are discharged per revolution.

History and Developments

There have been many designs for rotary positive displacement blowers and pumps. Reuleaux in his "Kinematics of Machinery," translated by Kennedy in 1876, describes a number of these. One of the earliest was the Pappenheim Pump, which has been traced back almost 300 years. Each of the two impellers of Pappenheim's pump was formed with six lobes; later modified to four lobes, and finally to a two-lobed form.

In 1854 at Connersville, Indiana, the brothers P. H. and F. M. Roots had a woolen mill using water power. They constructed a water motor with figure-eight shaped two lobed impellers of iron and wood. When this motor was being revolved slowly in their blacksmith shop, under test to check its internal clearance, one of the Roots brothers walked by in front of it and had his hat blown off. According to the legend, he exclaimed, "This would make as good a blower as a water motor," and conceived the idea of using the water motor to furnish blast air to the cupola in their nearby foundry. It was so much more satisfactory than the fan type blower then in use that this was the inspiration for starting the manufacture of the two impeller, positive pressure type machine which has become known the world over as the "Roots" type of blower. The early manufacture was for low pressure, in the neighborhood of one to two pounds per square inch, and the application largely for foundry cupola blowing and gas works exhausters.

Impeller forms that are used at present are sketched in Fig. 3.—(a) being the involute, most generally used for air blowing. The majority of activated sludge blowers are equipped with this form of impeller. The modified cycloidal (b) is used for high speed superchargers and vacuum pumps, as is also the cycloidal (c). The three lobed cycloidal type (d) is used as a liquid pump, and the three lobed epicycloidal type (e) is used on high speed supercharging installations, sometimes with spiraled impellers.

As early as 1890 two impeller blowers were being extensively used for medium pressure requirements. A Roots catalogue of 1890 states that there were 25,000 machines in service in America and Europe, the largest having a capacity of 215,000 CFM.

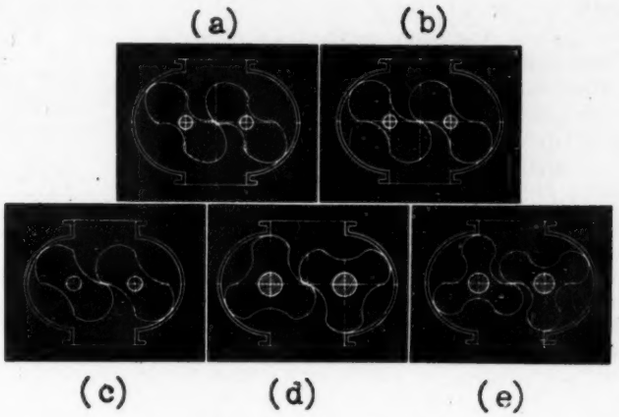


Fig. 3—Impeller Forms in Present Use
(A—Is the Volute Most Generally Used for Air-Blowing.)

Fig. 4 shows a machine as constructed by the Connersville Blower Company about 1910, with shafts in the horizontal plane. The Connersville Blower Co. was founded in 1893, an offspring of the P. H. and F. M. Roots Co., and operated in competition with the Roots Co. until 1930 when a consolidation was formed. The mechanical improvement over the early blowers was represented by better precision, closer clearances, adjustable babbitt lined bearings, precision cut timing gears, and a proportional reduction of the impeller length for higher pressures.

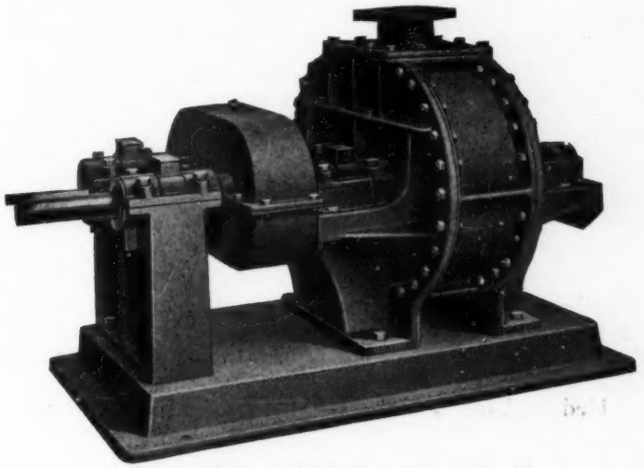


Fig. 4—1910 Model of Connersville Blower

About 1925 John T. Wilkin, then President of the Connersville Blower

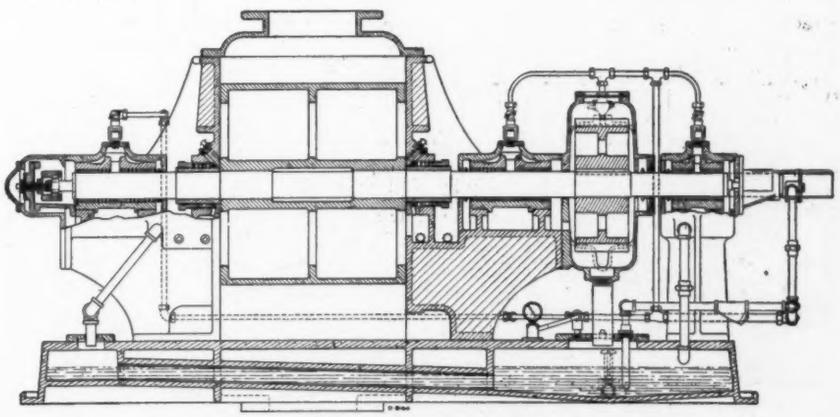


Fig. 5—1940 Model of "R-C" Blower in Cross Section

Co., patented a special form of timing gear called yielding tooth gears, in which four to five teeth are in mesh at all times. This type of gear proved a material advance, permitting pitch-line gear speeds up to 4000 ft. per minute as against 1800 ft./min. up to that time.

With higher speeds volumetric efficiency was improved, cost and weight reduced and, most important, the practical size of units was increased. About the largest practical single unit at this time for 8 lbs. pressure is 50,000 cu. ft. per minute.

Units of To-day

An interesting comparison is revealed in Fig. 4 and Fig. 5. The latter shows a cross-section of a present-day machine. The two parallel shafts are carried in renewable sleeve, babbitt lined bearings, and the gears are of the yielding tooth type. Pressure lubrication is furnished to the gears and bearings; an oil pump is driven from the idle shaft; the oil sump is usually in the bedplate and frequently an oil cooler is used. Thrust bearings are provided on the ends of the shafts opposite the drive, positively centering the impellers in the cylinder. The stuffing boxes prevent the possibility of any lubricant getting into the air flow and clogging the diffusers.

As stated, in the first "Roots" blowers impellers were made of wood. At an early date cast iron was substituted and is now the general standard. For some special services cast steel, welded steel and cast aluminum are used, and for corrosive services special alloys such as Monel, stainless steel, etc.

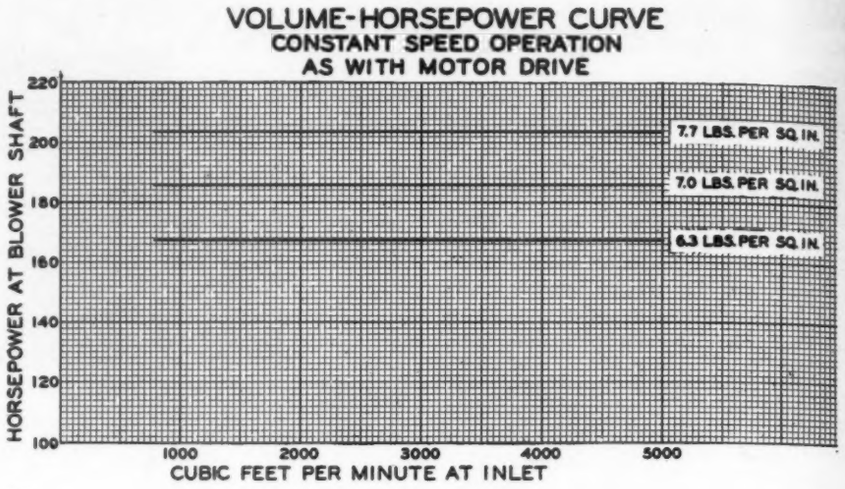


Fig. 6—Constant Speed Performance Graph

Operating Characteristics of Rotary Type Blowers

As previously stated, the impellers of rotary blowers operate within the case with finely gauged clearances, and *without* contact. There is no internal lubrication and no sealing medium. The clearances represent an orifice of practically constant dimension throughout the course of one revolution, and there is a flow backward through these clearances. Such back flow is referred to as "slip." The slip is directly proportional to the square root of the differential pressure across the impellers and inversely proportional to the square root of the density of the gas being handled. For convenience, the slip is expressed in revolutions per minute, and for a given size machine remains the same at any differential pressure regardless of the operating speed.

In most blowers operating at 5 to 8 lbs. pressure, as in sewage plants, the ratio of the slip to the speed is such as to give a volumetric efficiency of 85% to 95%. Capacity figured on the basis of slip test is extremely accurate and this method of testing rotary blowers has been recognized in the A.S.M.E. test code.

Volume-Pressure Relationships

The blower could well be called a positive volume blower, rather than a positive pressure blower. Unlike a centrifugal blower it has no inherent pressure characteristic. The operating pressure is determined only by the characteristics of the external system. In other words, the blower discharges against whatever pressure it has to build up. The elimination of valve losses, present in reciprocating compressors, and of eddy currents, found in centrifugal compressors, explains the high efficiencies of the rotary positive blower. Test efficiencies generally range from close to 80% adiabatic in large sizes, to 70% in small sizes, and are generally equal to or better than those attained by other types of equipment in the moderate pressure range.

The performance of one of these blowers at constant speed is illustrated in Fig. 6. The volume remains practically the same regardless of discharge pressure and the horsepower is directly proportional to the pressure. Fig. 7 shows multi speed operation. In this diagram horsepower is plotted against capacity for

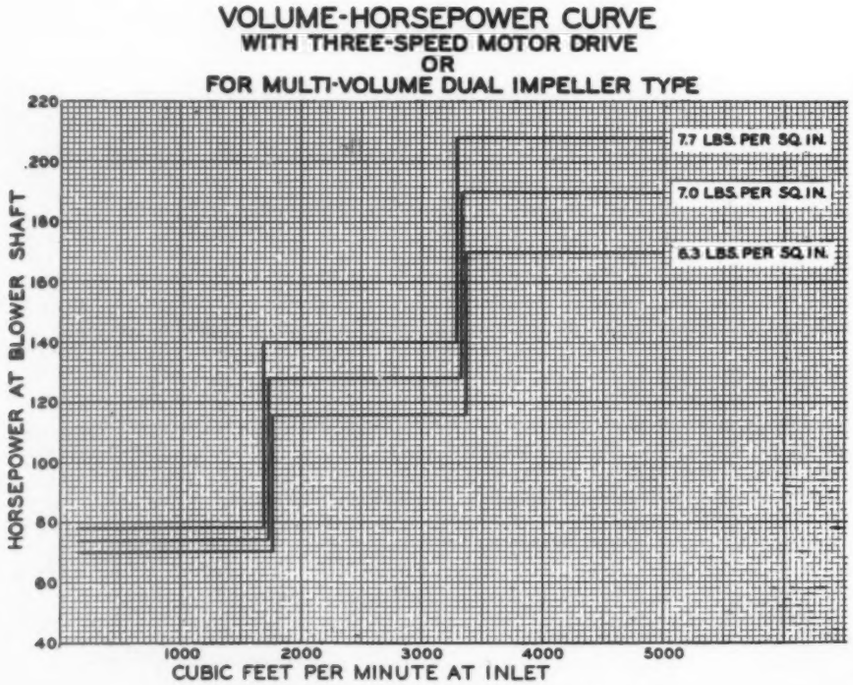


Fig. 7—Multi-speed Performance Graph

various pressures. The horsepower varies in steps as the speeds are changed. Fig. 8 shows variable speed operation, as with engine drive. The volume varies as a straight line with the speed and so does the horsepower for any given pressure. With variable speed operation the efficiency is practically uniform for any condition, the horsepower being directly proportional to the work done.

The diagrams reveal the horsepower consumption to be in direct proportion to the pressure. This is useful. A survey conducted of 20 sewage disposal plants indicates that they all have variation in air pressure. The average minimum pressure is 6.5 lbs.; the average maximum pressure 8.3 lbs.; and the average normal pressure 7.1 lbs. With the rotary positive blower a reduction in pressure affords a saving in power. Such is not possible with a constant speed motor driven centrifugal blower. If the plant could not utilize the additional volume that according to the characteristics of a centrifugal blower the lower pressure would bring, it would be necessary to throttle the difference and consume the full estimated power.

Temperature Effects

The performance of the rotary positive blower is unaffected by changes in inlet temperature, except for a slight effect on the slip. From 0° to 100° F. the capacity of a rotary positive blower of 500 HP size varies only 1½% and there is no variation in the horsepower consumption. This is in definite contrast to a centrifugal blower, where changes in air temperature have a considerable effect on the blower characteristics. In selecting the most favorable characteristic curve for a centrifugal blower, the question of variable air temperature is a real problem. Fortunately, air temperature variations can be ignored when considering a rotary positive installation.

Blower Output Control

In plants where rotary positive blowers are driven by constant speed motors variation in air capacity is obtained by having multiple units either of the same size or different sizes. In other plants multi speed induction or synchronous motors are used. These motors operate efficiently at two or three speeds, giving step control of capacity, as shown in Fig. 7. Wound rotor motors are not suitable for rotary positive blower speed control on this service, as with this constant torque application an equivalent amount of power is wasted in the resistors for any saving at the motor.

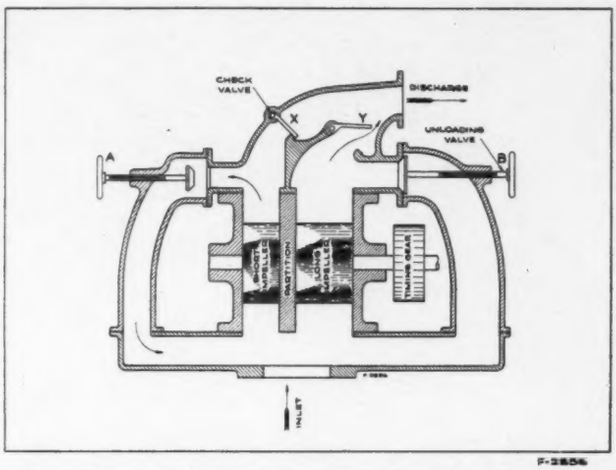


Fig. 9—Section Through the New "R-C" Dual Compartment Blower

(Two Blowers in One; Designed for Economy in Both First Cost and Operating Power.)

The Dual Compartment Blower

A recent and very interesting development is the dual compartment blower, shown in Fig. 9. The impeller compartment is divided into two sections, each of which represents a separate rotary positive blower, but for convenience both are assembled in the same case and carried on the same shafts and bearings. When valves A and B are both closed, both sections deliver into the line; when one or the other is open, that section is by-passed to the suction, without compression, inasmuch as corresponding check valve X or Y closes. This bypassing takes little power, representing but 1% or 2% of the total. With a constant speed motor this affords three different capacities, all with good efficiency, from a single unit.

Gas Engine Drive Ideal

Gas engine drive, with the engines operating on sludge gas, is an ideal method of drive for rotary positive blowers. It so happens that the most favorable speed of gas engines and

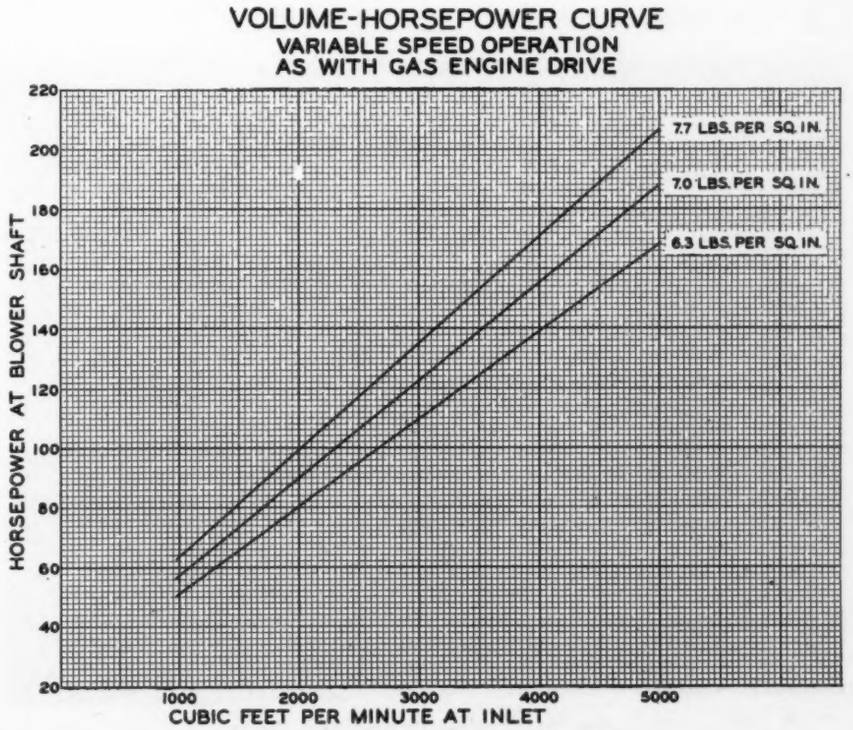


Fig. 8—Variable-speed Performance Graph

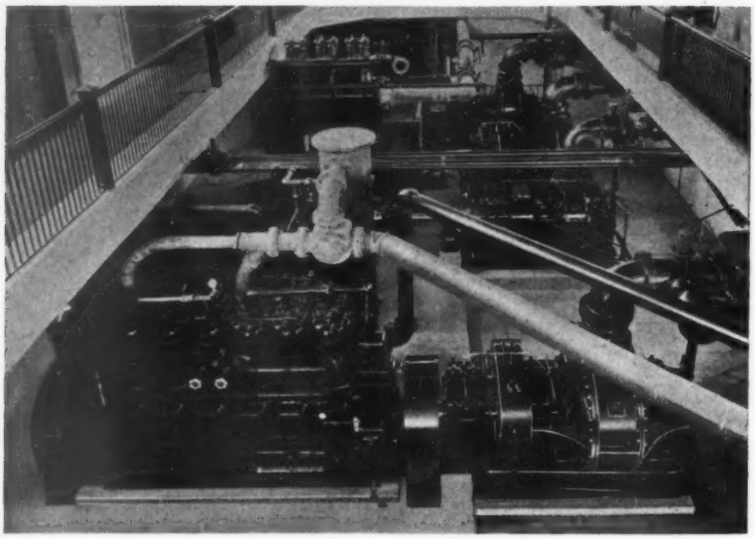


Fig. 11—Engine and Blower Room at Springfield, Ill.
(Here Gas Engine Power for Blower Drive Came Into Full Blossom Under Engineer Walraven's Forward Step.)

blowers is the same. The engine is always fully loaded as to torque, with good fuel economy at any speed, and the power required to drive the blower is in direct proportion to the load requirement. The accompanying table reveals figures on the fuel performance of two different sizes of engine driven blowers. The figures were obtained during shop test of blowers supplied for the Tallmans Island Sewage Disposal Plant of New York City. The practically flat fuel efficiency for any capacity from 50% to 110% is evident. If the blowers were driven by motor from a gas engine driven generator, at least 25% more average fuel would be required to make up for generator and motor electrical losses, variation in blower efficiency, and reduced engine fuel economy, when the generator was partly loaded. A typical engine fuel curve is shown in Fig. 10, revealing an increase from 9500 BTU per hour to 11,500 BTU per hour from 100% load to 50% load. For loads under 50% there is even a greater increase in fuel consumption. As above stated, when the rotary blower is direct connected to the engine, regardless of speed, the engine loading which is a function of the MEP stays constant and at an efficient point.

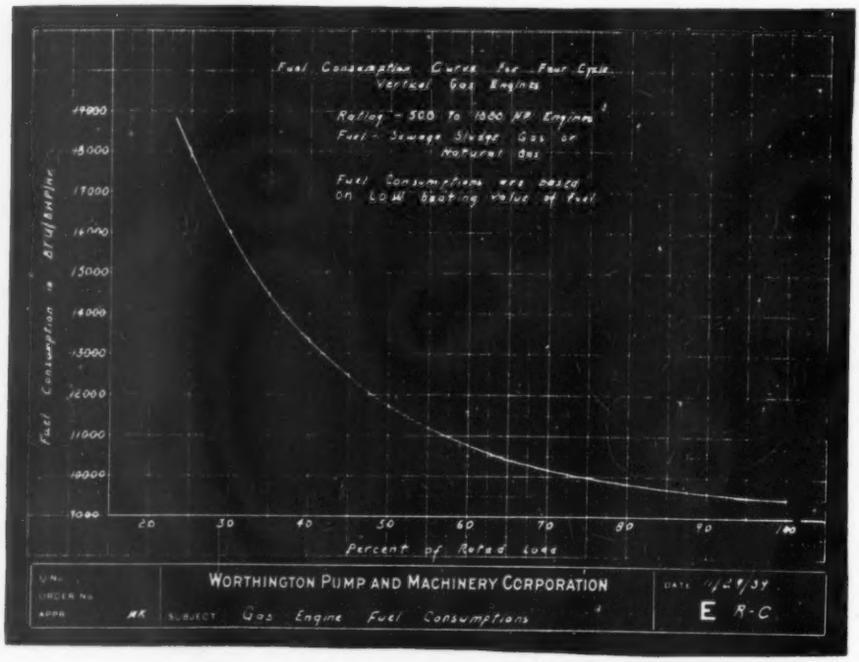


Fig. 10—Typical Engine Full Curve
(Denotes Efficiency of Blower Operation by Direct Drive from Gas Engines.)

Blower Size 36 x 41½"
20,000 CFM RATING:

Cap.	110%	100%	69%	50%
CFM	22,042	20,267	13,685	10,130
BHP	852	798	525	401
Blower Eff.	77.6%	75.8%	77.5%	75.4%
Engine BTU per CF Air delivered	6.26	6.33	6.48	6.70

Blower Size 28 x 31¼"

10,000 CFM RATING:

Cap.	110%	100%	75%	50%
CFM	10,990	10,064	7,642	4,991
BHP	441.5	406.5	312	219
Blower Eff.	74.0%	73.5%	72.4%	67.2%
Engine BTU per CF Air delivered	6.28	6.38	6.49	6.69

Several installations, initially made with direct connected motor driven blowers, have been changed and the motors replaced with gas engines. Two notable examples of these are the plants at Peoria and Springfield, Ill., the latter installation being pictured in Fig. 11.

Claims for great flexibility have been made for engine driven generators driving motor driven blowers, but a more flexible plant can be designed with direct connected blowers, without loss through reconversion of power. In addition there results a saving in installation costs. The gas generated is usually sufficient to provide all air needed. If it is anticipated that there will be additional gas available, engine driven generators can be supplied to furnish other power requirements such as for driving pumps. The merits of various types of installations will be better known when operating cost figures are available on those recently placed in service, and others soon to be placed in service. There are now 33 installations comprising 45 machines, totalling 8720 HP of direct connected, gas engine driven, rotary positive blowers in activated sludge plants. From this number conclusive proofs should be forthcoming.

With higher operating speeds it became desirable to muffle the blower inlet noise. For the most part, silencers have been used. The central core of such silencers is a perforated tube, the same diameter as the intake pipe size, around which is packed a sound absorbent material. These silencers when properly installed are quite effective and afford a plant with a low noise level, while presenting no greater resistance to flow than an equivalent length of pipe.

Summarizing, we might list the following distinct advantages for the rotary positive type blowers:

1. They operate at moderate speeds, suiting them for direct connection to highly efficient, moderate speed, synchronous motors and gas engines.
2. Due to their moderate speed the maintenance cost is extremely low.
3. They have an inherent high efficiency unaffected by changes in air temperature and discharge pressures.
4. They have a positive volume characteristic so that tachometers on the blowers can be used for air meters: i.e., the blower itself is the meter, driven by power rather than by the air passing through.
5. With rotary positive blowers there is no instability when operating a single machine at reduced capacity or when operating more than one machine in parallel.

Representative Installations

The first installation of a rotary positive blower in an activated sludge plant was in the Jones Island Plant at Milwaukee in September 1915 where, in an experimental plant, there were installed three Roots rotary positive pressure blowers. Other early installations were in the Sanitary District of Chicago in 1915 and Swift & Co. at Fort Worth, Texas, in 1919. Since these early blowers were supplied for sewage treatment there have been installed in all sizes approximately 300 rotary positive blowers (totalling 23,000 HP.) in 140 activated sludge plants.

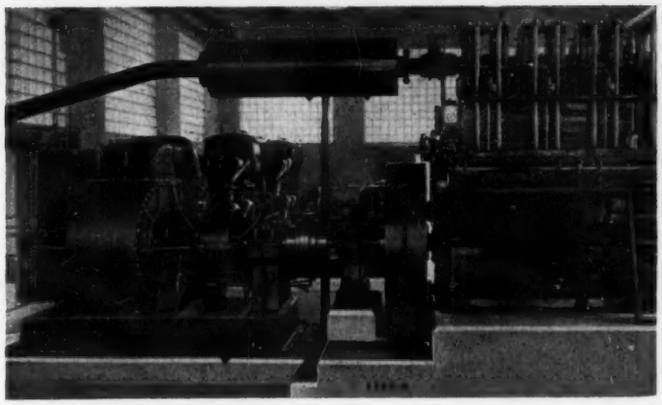


Fig. 13—At Lansing, Mich.—A 5000 CFM. Blower at 400 RPM Worthington Engine Driven

In a survey of 20 plants the following average figures of interest to engineers were obtained.

Air Use—Cu. ft./gal. of sewage	1.09
Air Use—Cu. ft./min./capita	0.066
K.W. Input per Month/Capita	0.71
Gas Production Cu. ft./Capita/24 hrs.	1.01
Gas Production Cu. ft./1000 gals. sewage	12.50
B.O.D. Reduction	93%

Some pertinent facts concerning typical rotary blower installations in sewage treatment plants may likewise prove interesting.

Springfield, Ill.—(Fig. 11)

At the treatment plant of Springfield, Ill., where Walraven made the first conclusive demonstration of the economy and practicability of blower operation by direct drive from a gas engine, utilizing sludge gas as fuel, there have been three direct motor driven rotary blowers (200, 150 and 100 HP) in service since 1931. The 150 HP unit was changed over to gas engine drive and the benefits derived justified an additional direct 200 HP gas engine driven unit. The present appearance of the Springfield blower room is pictured in Fig. 11.

New York City, Tallmans Island—(Fig. 12)

The four blowers installed at the Tallmans Island Sewage Disposal Plant in the City of New York are shown in Fig. 12. The two blowers in the foreground are rated at 10,000 CFM against 8 lbs. pressure and are direct connected to four cylinder, 450 HP, Worthington gas engines operating at 327 RPM. The two

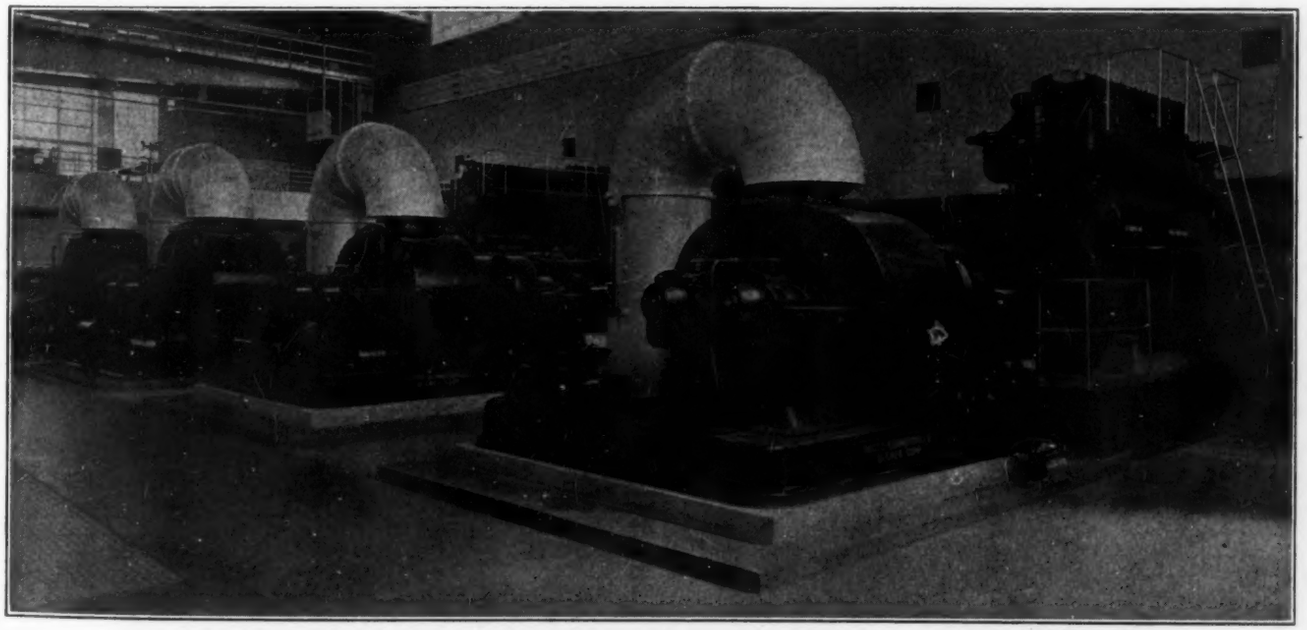


Fig. 12—New York City at Tallmans Island Has the Largest Installation of Engine Powered Blowers
(Worthington Engines Drive Two 20,000 C.F.M. "R-C" Blowers at 300 R.P.M. and Two 10,000 C.F.M. "R-C" Blowers at 327 R.P.M. The Engines Operate Almost Wholly on Sludge Gas. The Slight Deficiency Being Taken from the Gas Company's System Automatically.)

blowers in the background are rated at 20,000 CFM each and are direct connected to Worthington eight cylinder, 800 HP gas engines operating at 300 RPM.

The sewage pumps in this plant are also gas engine driven. The experience to date has been that during the summer there is an excess of sludge gas over the power requirements of blowers and pumps, and in the wintertime it has been necessary to purchase some outside power, in the form of city gas for supplementing the digester gas at intervals. The air is metered by having electric tachometers on the blowers, each indicating separately on a panel board behind the blower in both RPM and CFM. The individual tachometer readings are added electrically and indicated and recorded on a master panel, thus eliminating the necessity for having Venturi or orifice meters.

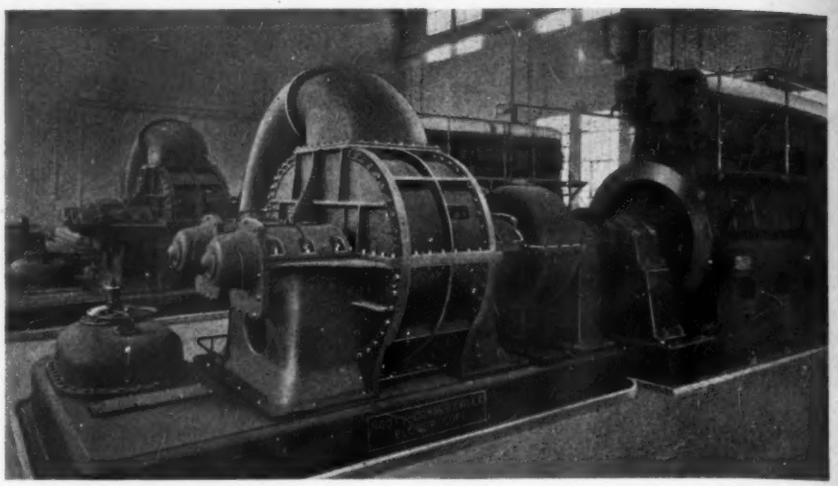


Fig. 16—The Two Blowers at Cleveland's Southerly Treatment Works
(Direct Driven by 400 H.P. Cooper-Bessemer Engines at 400 R.P.M. Are Rated at 10,000 C.F.M. Each, 7½ lbs. Pressure.)

Lansing, Mich.—(Fig. 13)

Of the three blowers installed at the Lansing plant, two are motor driven units of the dual compartment type, 4000 CFM each maximum capacity, driven with 200 HP, 575 RPM motors. The third is a gas engine driven unit rated at 5000 CFM, 240 HP, 8 lbs. pressure, engine rated at 392 RPM.

Providence, R. I.—(Fig. 14)

The three blowers are rated at 13,000 CFM, 7 lbs. pressure and are direct connected to 400 HP, 400 RPM synchronous motors with direct connected exciters. The motors are of the two speed type operating also at 200 RPM at which speed they have a rating of 200 HP and a blower volume of 6000 cu. ft. of air per minute. At 13,000 CFM and 7 lbs. pressure these blowers showed a blower efficiency of 78% and an overall efficiency including motor losses of 74%.

Lancaster, Pa.—(Fig. 15)

Two blowers installed are of the flexible dual compartment type, previously described. These are equipped with two speed motors so that six air capacities are available, ranging from 640 CFM in gradual steps to 4855 CFM at 7½ lbs. pressure. This blower showed an overall blower efficiency of 75% at its maximum rating and at its minimum rating (640 CFM each against 7½ lbs.), 67% efficiency.

Greensboro, N. C.

The installation consists of three blowers of the dual compartment type, providing three different capacities, 650, 1150 and 1750 CFM. These are driven with 75 HP motors.

Cleveland, Ohio—(Fig. 16)

The two blowers installed at the Southerly Plant at Cleveland are each

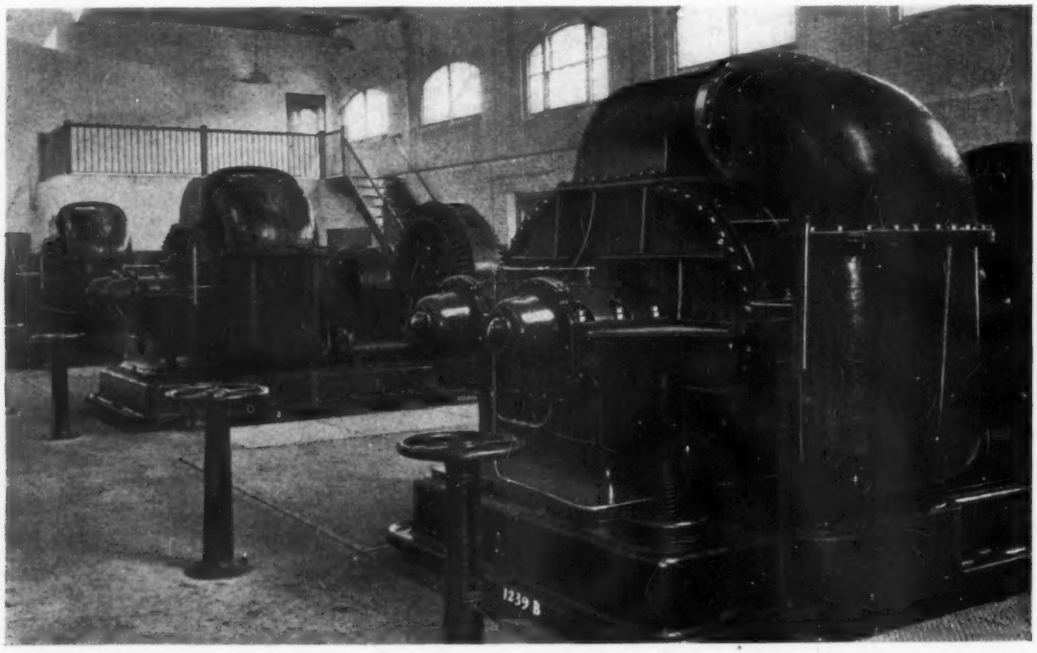


Fig. 14—Providence, R. I., Has Three 13,000 C.F.M. Blowers Driven by Two Speed Motors
(Here the Power Is Generated in a Rubbish and Garbage Incineration Plant Next Door.)

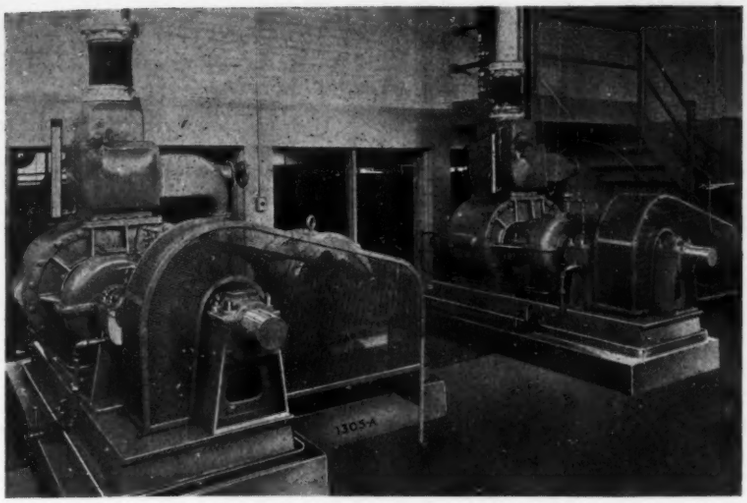


Fig. 17—At Leominster, Mass.
(Two Small Units of the Dual Compartment Type Are Motor Driven to Produce 1400 C.F.M. Each at 440 R.P.M.)

rated at 10,000 CFM, 7½ lbs. pressure. They are direct driven by 400 HP, 400 RPM, Cooper-Bessemer gas engines.

Topeka, Kan.

The two blowers installed are rated at 4050 CFM and are direct connected to Worthington gas engines, 180 HP, 400 RPM.

Leominster, Mass.—(Fig. 17)

The two blowers installed are of the dual compartment type, maximum capacity 1400 CFM each, at 6½ lbs., requiring 54.5 HP at 440 RPM. They are operated through V-belt drive by squirrel cage motors. The drive shafts are extended, however, for future connection to gas engines.

Minneapolis-St. Paul—(Fig. 18)

The three blowers installed in the plant of the Minneapolis-St. Paul Sanitary District are 1200, 1800 and 2400 CFM, respectively, against 6 lbs. pressure with 40, 60 and 75 HP motors. The two smaller machines operate at 870 RPM and the larger machine operates at 690 RPM.

The Minneapolis-St. Paul plant is the only one included in this review which is not an activated sludge plant, the air being used in chemical mixing and varied other applications.

There are numerous other installations of this type blower already in use or projected in sewage disposal plans. The preceding illustrations were selected to give a general idea of the physical appearance and units comprising these installations.

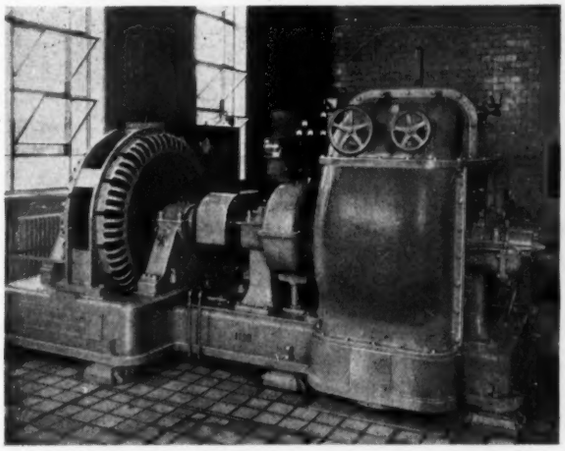


Fig. 15—At Lancaster, Pa.—Two Blowers of the Flexible Dual Compartment Design
(Driven by Two-Speed Motors These Two Blowers Provide Six Air Capacities at Overall Efficiencies for Minimum to Maximum Output of 67% to 75%.)

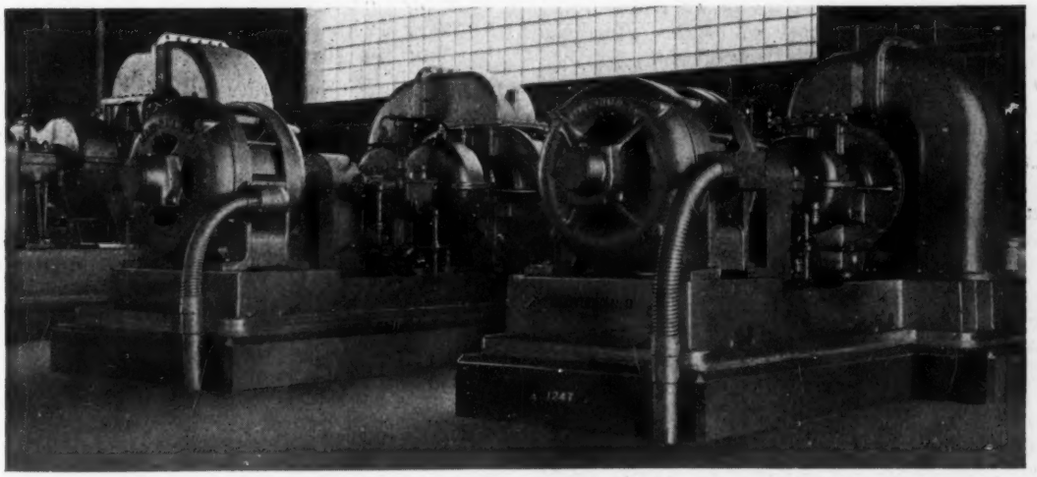


Fig. 18—At the St. Paul-Minneapolis Plant
(Three Blowers of 1200, 1800 and 2400 C.F.M. Capacities at 6 Pounds Pressure. This Plant is a Chemical Precipitation Plant Which Uses Air for a Variety of Purposes.)

The Editor's Comments

Giving the Young Man a Chance

IN MOVING around the country visiting water and sewage plants, and becoming acquainted with the management and operating personnel of city owned plants two matters worthy of more thought have frequently been impressed on this writer. These are: (1) the lack of incentive offered municipal plant employees; (2) that the younger men are so often stymied by old men.

In respect to the first matter, an employee of the municipally owned plant will rarely ever receive adequate recognition for outstanding services or any act performed beyond his regular line of duties. In consequence, there is a deplorable lack of incentive which will encourage the industrious and ingenious man to give his job the consideration that otherwise he would. In municipal, county, state and federal employment there is a lamentable lack of possible reward to the employee who "does things". By this is meant the performance of a service, the invention of a device, or perfection of a process of peculiar value, which improves operation, cuts costs of operation or maintenance, or accomplishes both.

In a very limited number of cities there is in operation a merit or credit system, and such a development is laudable and encouraging. It is deserving of more attention by the many cities which have no such system for rewarding outstanding or exceptional employees who perform services or contribute betterments benefitting taxpayers.

The Merit System of Dallas, Texas, is one such award system of which we have more first hand knowledge than any other. In the Dallas system there is no direct cash reward, but rather the employee who is voted the credit, or award, is given an advance in his Civil Service rating as a reward for extraordinary services, proficiency, or a contribution represented by improved operating methods or equipment. This boost in rating of course lends to an advance in salary when the higher rating carries with it a higher salary.

In one specific instance the Superintendent of Filtration at Dallas, by altering the method of raw water preparation and introduction of an improved coagulant, brought about an annual reduction of $4,000 in chemical costs in treating the water supply of Dallas. For this service he was rated up 7 points by the Civil Service Board. These 7 points representing the maximum allowed for a single citation and advancement in position. Ordinarily the "normal" advancement on any single citation is 1¾ points, with others falling between this number and the 7 points awarded L. C. Billings for his valuable contribution.

The custom is that of requiring department heads to enter an appraisal of all employees at intervals of 90 days. The system works both ways and a deficiency rating coats the dillatory or non-dependable employee 1 or more points in his Civil Service rating. All Civil Service employees enter with a rating of 75% and through the Merit System can attain a 100% rating in time. If his demerits reduces his rating to 70% or less for any sustained period he is subject to dismissal.

Under Civil Service the Department of Water Supply and Sewage Disposal of Dallas has operated satisfactorily for eight or more years without political interference. Based on such a period of experience with the method Sup't. J. B. Winder, is an ardent advocate of the Merit System as a means of rewarding deserving employees and weeding out the in efficient. It has proven its worth to all concerned.

We would like to see a merit system which goes a step further. Where it can be shown, without question, that an employee has instituted a method or perfected a device saving many dollars for the city that he be rewarded in the form of a cash bonus worked out on a percentage basis computed from the net savings which can be credited to such employee. Or, in lieu of a bonus in cash, the reward might take the form of an increased annual contribution by the City to any pension or retirement fund accumulating to the credit of the employee.

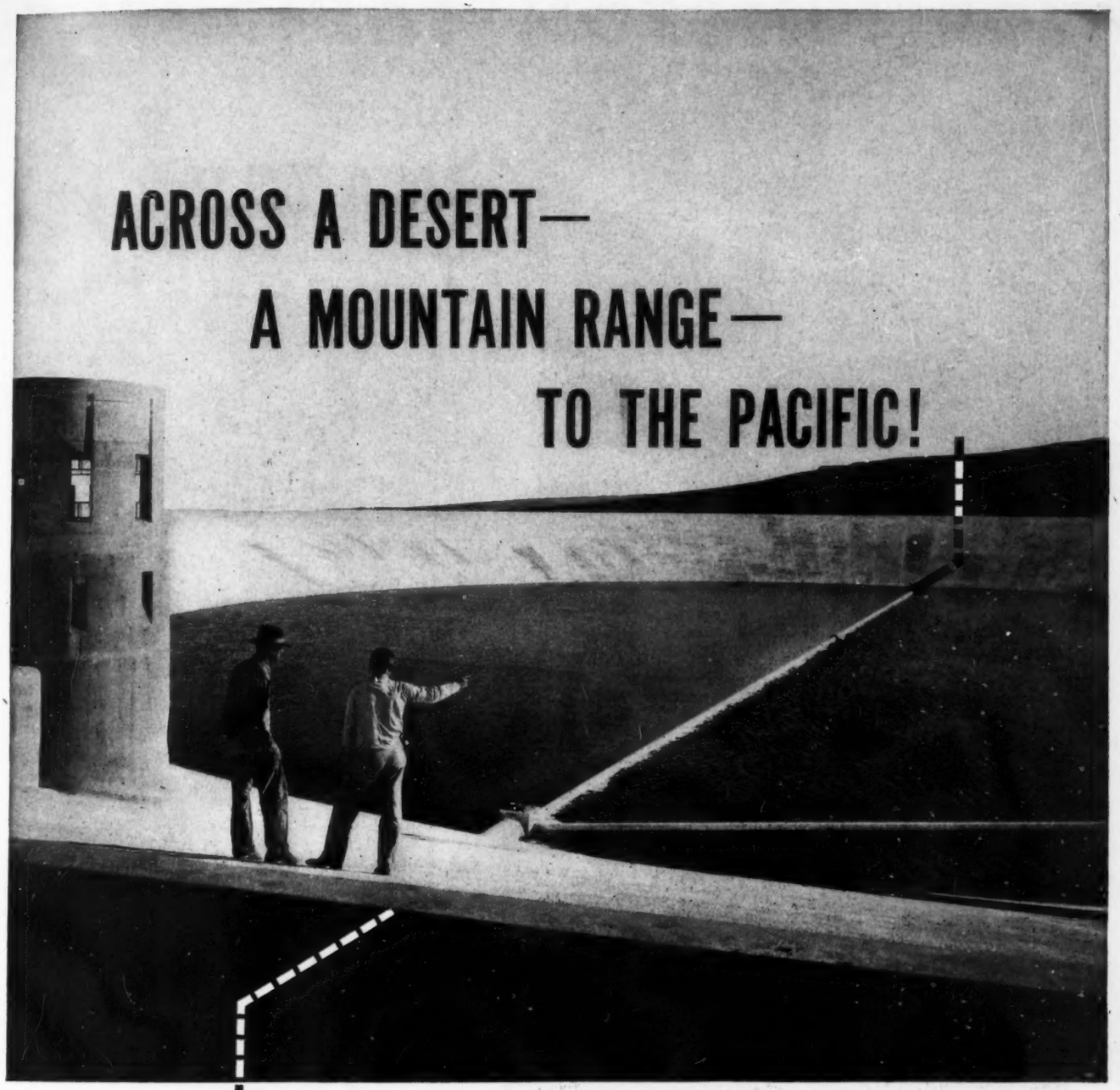
The second matter that doesn't persent an encouraging picture of opportunity in municipal utility operation is that of the old employee, who for lack of a retirement plan, or who because of a desire to "die in harness" does not step aside and give the younger man the deserved opportunity for advancement. Realizing full well that experience has great value, we also realize that the services of these older men need not be lost by moving up the deserving understudy to the position where he may go ahead more on his own initiative and responsibility, to make improvements which the older man is frequently slow to accept.

The basic causes for greater conservatism in "old man" management will not be analyzed here, but the chief cause is that of "little to gain—much to lose" in mistaken departure from precedent or failure of a new and promising scheme at so late a period in ones professional career. Such philosophy should not be permitted to stymie the young man and a permanent place could well be made within the active organization for the older man while the younger man is given the position and responsibility which, if the right sort, he has long awaited and looked forward to in his understudy days. The old manager can well be retained as a sort of "Chairman of the Board" or "Advisory Manager". The point is that a place can be made for the experienced man and thus avoid losing his services, such as would be the case if he be retired or pensioned. At the same time he is relieved of arduous duty and responsibility which is better carried on younger shoulders.

What brought this last consideration to mind at this writing is the recent retirement of Colonel Rich, as head of the Bureau of Engineering of the Michigan State Dep't. of Health. After 27 years of service Colonel Rich took the position that he should stand aside and let his younger Principle Assistant Engineer "take over" as head of the Bureau. But the Department is fortunate in that it has a place for the retiring Colonel, and into this position he will step to become advisor and consultant, while the responsibilities of managing and running the Bureau will pass onto the younger shoulders of his former understudy. Thus the former Bureau head is neither retired nor is his experience and counsel lost to the Department, whereas a young man has come into a deserved position and others down the line have moved up.

It is our thought that this pattern may well be copied by municipalities and other political subdivisions, to the advantage of all concerned. It seems an admirable solution to the problem of retirement vs. continued service and arrested advancement vs. promotion.

L. H. Enslow



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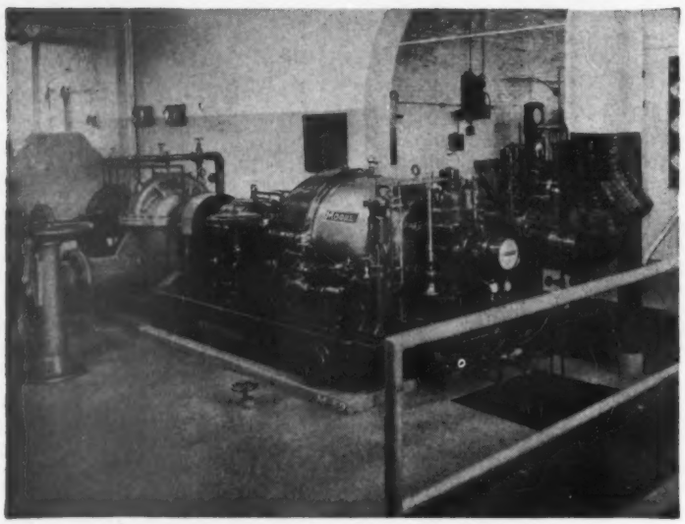
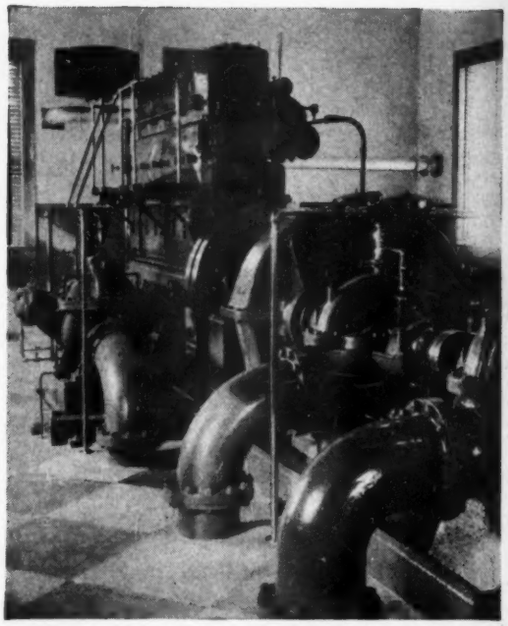
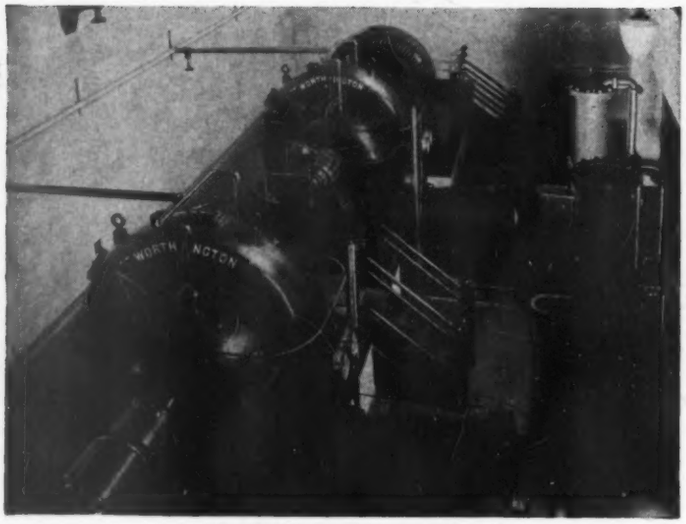


STEAM TURBINE DRIVEN UNITS



DIESEL OR GAS ENGINE DRIVEN UNITS



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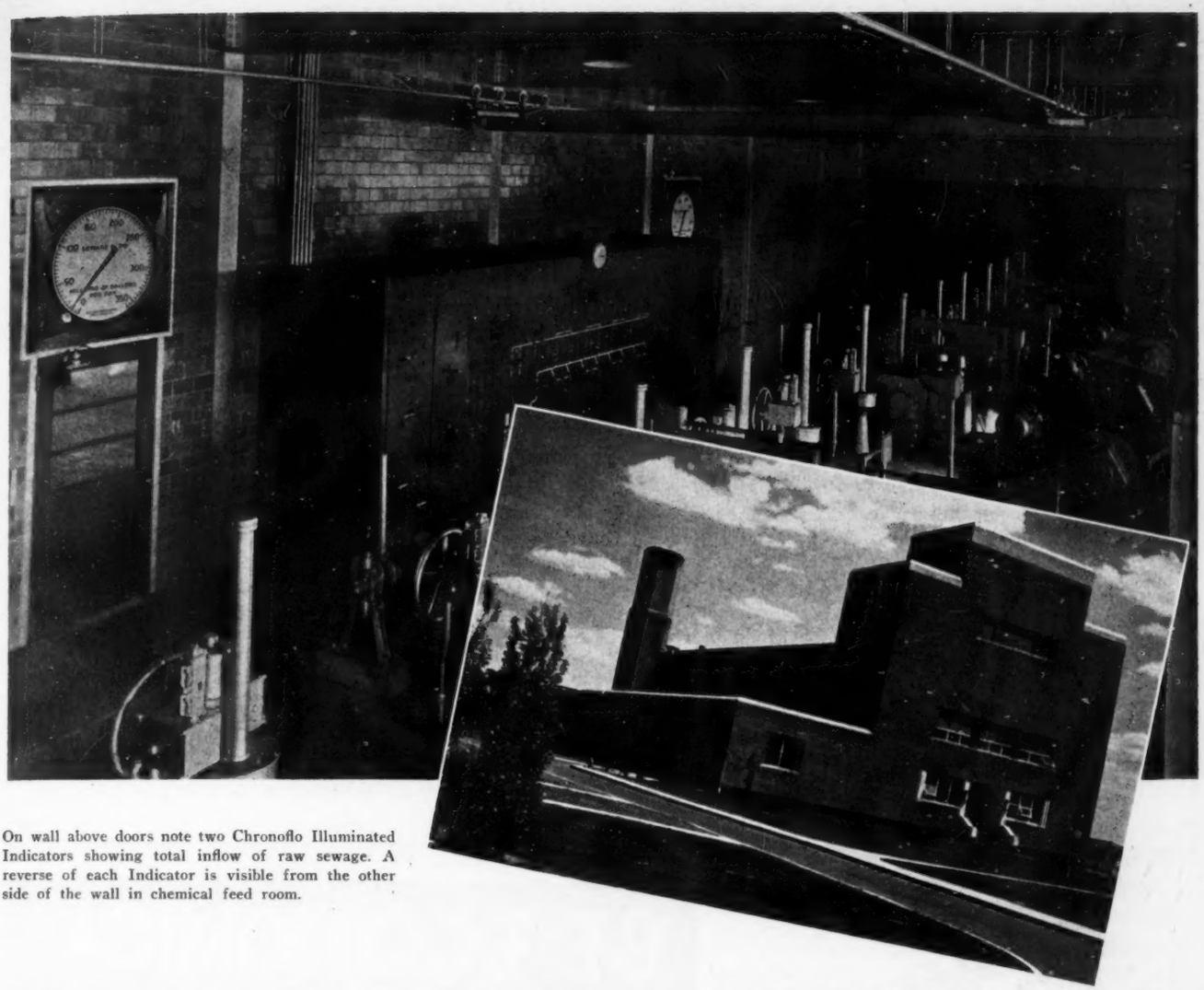

On wall above doors note two Chronoflo Illuminated Indicators showing total inflow of raw sewage. A reverse of each Indicator is visible from the other side of the wall in chemical feed room.

Minneapolis—St. Paul "highly pleased"

In a recent letter, George J. Schroepfer, Chief Engineer and Superintendent, expresses himself as "highly pleased" with the operation of their Builders Meters and then adds:

> **"I cannot miss this opportunity of thanking you for the fine follow-up service which your concern has given us. I am sure that you will be well repaid in the opinions expressed to visitors by all of the men in the plant concerning the high quality of your equipment."**

New and difficult metering problems were encountered, such as: the automatic summation of individual meters in the Minneapolis District; the long distance transmission to the plant on Pigs Eye Island of the total flow and total rate; and the measurement of heavy sludge containing as high as 20% of solids.

Practically every sewage treatment plant presents problems in metering flow of raw sewage, air, mixed liquor, sludge, and elutriation water. Our long experience is available to you.

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CLEANING UP
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Guaranteed restoration of carrying capacity to at least 95% of new main. The National Method for over 30 years has given—GREATER DELIVERY, LOWER PUMPING COSTS, REDUCED INSURANCE RATES, CLEAN WATER. *An inquiry does not obligate you.*

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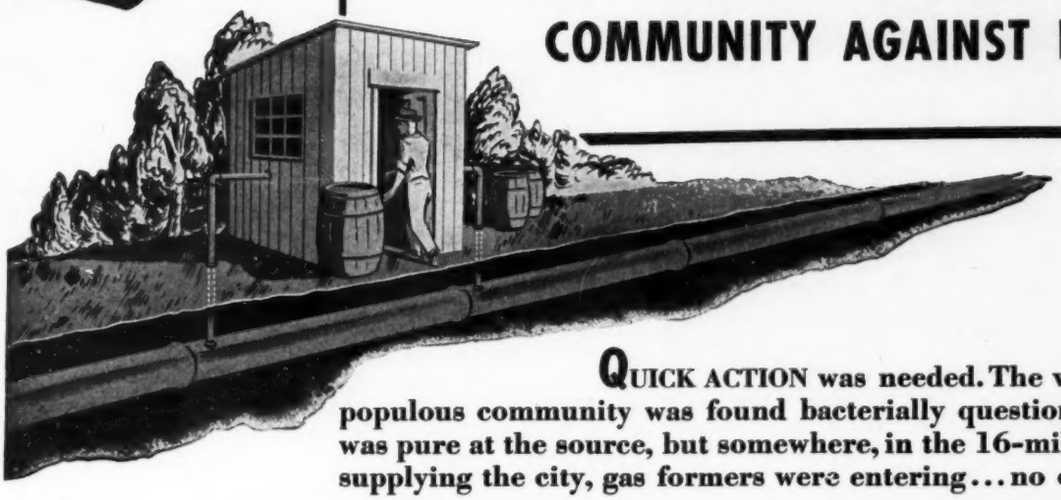
Quick Treatment

WITH PERCHLORON PROTECTED THIS COMMUNITY AGAINST DANGER



QUICK ACTION was needed. The water supply of a populous community was found bacterially questionable. The water was pure at the source, but somewhere, in the 16-mile pressure main supplying the city, gas formers were entering... no one knew where.

The time required for a systematic search would leave the community unprotected too long. The supply had to be sanitized immediately without waiting for special chlorinating equipment.

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SANITATION EQUIPMENT

MEETINGS SCHEDULED

Sept. 16-17—DENVER, COLO. (Cosmopolitan Hotel)
Rocky Mountain Section A. W. W. A. Secretary, R. V. Howe, State Office Bldg., Denver, Colo.

Sept. 16-17—SAN DIEGO, CALIF.
California Sewage Works Association. (13th Annual Fall Convention.) Sec'y., Wm. T. Ingram, Stockton, Calif.

Sept. 18-20—NEW CASTLE, PA. (Castleton Hotel)
Western Pennsylvania Section A.W.W.A. Sec.-Treas., E. P. Johnson, 418 Flannery Bldg., Pittsburgh, Pa.

Sept. 21—CLEMENTON, N. J. (Silver Lake Inn)
New Jersey Sewage Works Association (Annual Outing). In charge of arrangements, Edw. P. Hyland, Sup't. Water & Sewerage, Town Hall, Moorestown, N. J.

Sept. 24-27—NEW YORK, N. Y. (Commodore Hotel)
New England Water Works Association. (59th Annual Convention). Secretary, Frank J. Gifford, 613 Statler Bldg., Boston, Mass.

Sept. 25—NEW YORK, N. Y. (Commodore Hotel)
New York Section A.W.W.A. Sec'y., R. K. Blanchard, 50 West 50th St., New York City. (Luncheon meeting during the N.E.W.W.A. Convention.)

Sept. 26-28—WAHPETON, NORTH DAKOTA
North Dakota Water & Sewage Works Conference. Sec'y.-Treas., Lloyd K. Clark, State Dep't. of Health, Bismarck, N. D.

Sept. 30-Oct. 2—DETROIT, MICH. (Book-Cadillac Hotel)
American Public Works Association. Exec. Director, Frank W. Herring, 1313 E. 60th St., Chicago, Ill.

Oct. 1-2—COLUMBUS, OHIO (Neil House)
Ohio Conference on Sewage Treatment. Sec'y., B. M. McDill, State Department of Health, Columbus, Ohio.

Oct. 3-4—COLUMBUS, OHIO (Neil House)
Ohio Conference on Water Purification. Sec'y., T. R. Lathrop, State Dep't. of Health, Columbus, Ohio.

Oct. 3-5—CHICAGO, ILL. (Hotel Sherman)
First Annual Convention
Federation of Sewage Works Associations
Sponsored by
Central States Sewage Works Association
Gen'l Chairman, George J. Schroepfer, Box 3598, St. Paul, Minn. Local Chairman, Dr. F. W. Mohlman, San. Distr. of Chicago, 910 So. Michigan Blvd., Chicago. Sec'y.-Treas. Central States Ass'n., W. H. Wisely, Ill. State Dept. of Health, Springfield, Ill.

Oct. 4-5—STAFFORD, ARIZ.
Arizona Sewage & Water Works Ass'n. Sec'y.-Treas., F. C. Roberts, Jr., State Board of Health, Phoenix, Ariz.

Oct. 8-11—DETROIT, MICH. (Book Cadillac Hotel)
American Public Health Association. Exec. Sec'y., Dr. Reginald M. Atwater, 50 West 50th St., New York City.

Oct. 9—MILLINOCKET, ME.
Maine Water Utilities Association. Sec'y.-Treas., Earle A. Tarr, Winthrop, Me. (Future Meeting—Dec. 12—Mexico.)

Oct. 14-17—TULSA, OKLA. (Mayo Hotel)
Southwest Section A.W.W.A. Secretary, Lewis A. Quigley, 3320 W. Berry Street, Fort Worth, Texas.

Oct. 14-16—MANITOWOC, WISC. (Hotel Manitowoc)
Wisconsin Section A.W.W.A. Sec'y.-Treas., L. A. Smith, City Hall, Madison, Wisc.

Oct. 16-19—ATLANTA, GA. (Georgia School of Technology)
Georgia Water and Sewage Association. Sec'y., Paul Weir, 1210 Hemphill Ave., Atlanta, Ga.

Oct. 16-17—SPRINGFIELD, MASS. (Hotel Kimball)
New England Sewage Works Association. Sec'y.-Treas., LeRoy W. VanKleeck, State Dep't. of Health, Hartford, Conn.

Oct. 16-18—ATLANTIC CITY, N. Y. (Haddon Hall)
Pennsylvania Water Works Association. (45th Annual Meeting.) Secretary, F. Herbert Snow, 507 Telegraph Bldg., Harrisburg, Pa.

Oct. 18-19—Atlantic City, N. J. (Madison Hotel)
New Jersey Section A.W.W.A. Sec.-Treas., C. B. Tygert, Box 178, Newark, N. J.

Oct. 17-18—Mitchell, S. D. (Hotel Widman)
South Dakota Water & Sewage Works Conference. Secretary, W. W. Towne, Pierre, S. D.

Oct. 21-23—Lexington, Kentucky (Hotel Lafayette)
Kentucky-Tennessee Section A.W.W.A. Sec.-Treas., H. D. Schmidt, State Dept. of Health, Nashville, Tenn.

Oct. 22-23—Springfield, Ill.
Illinois Water Works Operators. (Annual Fall Meeting). Secretary, C. W. Klassen, Department of Public Works, Springfield, Ill.

Oct. 23-26—Los Angeles, Calif. (U. S. Grant Hotel)
California Section A.W.W.A. Secretary, Burton S. Grant, 207 So. Broadway, Los Angeles, Calif.

Oct. 24-25—Springfield, Mo. (Colonial Hotel)
Missouri Water & Sewerage Conference. Secretary, Warren Kramer, State Board of Health, 200 Monroe St., Jefferson City, Mo.

Oct. 24-26—Huntington, W. Va. (Prichard Hotel)
West Virginia Section A.W.W.A. Sec'y.-Treas., J. B. Harrington, Dep't. of Health, Charleston, W. Va.

Oct. 28-30—Raleigh, N. C. (Sir Walter Raleigh Hotel)
North Carolina Section A.W.W.A. Sec'y.-Treas., R. S. Phillips, 319 E. Trinity Ave., Durham, N. C.

(Meeting jointly with)

North Carolina Sewage Works Association. Sec'y., M. F. Trice, State Board of Health, Raleigh, N. C.

Nov. 7-8—St. Paul, Minn. (Hotel St. Paul)
Minnesota Section A.W.W.A. Sec.-Treas., R. M. Finch, W. & T. Co., 416 Flour Exchange, Minneapolis, Minn.

Nov. 7-8—Wilmington, Del. (Hotel Du Pont)
Four States Section A.W.W.A. Sec'y.-Treas., Carl A. Hechmer, Washington Suburban Sanitary Dist., Hyattsville, Md.

Nov. 13-15—Omaha, Neb. (Fontenelle Hotel)
Missouri Valley Section, A.W.W.A. Sec'y.-Treas., E. L. Waterman, Univ. of Iowa, Iowa City, Ia.
803 Water Board Bldg., Detroit, Mich.

LITERATURE AND CATALOGS

"New Bleaching Clay for Taste and Odor Control" is featured in the August issue of "Activated Alum News," published by Activated Alum Corp. Therein is an interesting recounting by Chief Chemist R. W. Fitzgerald, of experiences and results at the Norfolk, Va., filter plant with Activated Alum's recently introduced Chlorinated Bleaching Clay which this firm of water treatment specialists has developed as a remover of tastes and odors, coagulation improver and "dragger-downer" of a variety of organic colloids from water by the process of clay adsorption so well recognized in natural processes of stream purification and in water treatment generally. This experience at the Norfolk plants where taste and odors are prevalently a problem (shallow swampy reservoirs cause the trouble) makes interesting reading for any operator or superintendent. If you do not receive "Activated Alum News" write for the August, 1940, issue and get on the regular mailing list. This publication misses no bets in presenting helpful suggestions and snappy ideas month by month. If you wish to receive it tell Activated Alum Corporation, Curtis Bay Station, Baltimore, Md.

pH Test and Control Equipment is subject of a recently issued 28 page bulletin presenting the complete line of the well known Hellige testing equipment for determining pH, and in making residual chlorine tests and others involving color standards. The feature of Hellige Test Sets (from the simplest pocket kit to the elaborate "Helige pH Laboratory") is the adaptation of glass permanent color standard discs, first introduced by Hellige who emphasizes that a lifetime accuracy is

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For more than 25 years, engineers and operators have recognized the fact that corrosive soil action quickly breaks down most types of ferrous pipes. It takes a tough, durable coating to assure long life and low-cost service.
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Authorities agree that only asbestos pipe-line felts give positive assurance of long life and low upkeep. Be sure you get full protection by using J-M Felts. They're made of inorganic, non-tubular asbestos fibers . . . cannot support capillary action. Their unusual strength and durability prevent distortion or abrasion of the coating. And they effectively resist all forms of corrosion . . . keep maintenance at permanently low figures.

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HANDLES 15,000 GALS. PER HR.

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Easy to carry around and built for excessive use, this pump is a natural for your type of work. Ask some of the thousands of Homelite users. Send for bulletin.

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WABASH, INDIANA

guaranteed. Another feature is the compactness and simplicity of manipulating Hellige's test sets. One tester named the Hellige "Simplex" (the simplest of them all) is designed for wide range testing with glass color standards always in place. The Standard Hellige Testers have the removable discs for more refined testing. An improvement is found in the adaptation of the new "G.E." plastic—"Textolite"—for all cases and multi-standard discs. The new bulletin also presents the improved "Hellige Aqua Tester", the Hellige Turbidimeter", involving no standards; "Hellige Bacterial Counting Plates", "Hellige Duboscq Colorimeter"; and the "Hellige pH Meter" which determines pH electrometrically and employs the reliable improved glass electrodes. A full listing of all Color Standards and Indicator Solutions completes the new bulletin. Every laboratory should have a copy. For Bul. No. 602 write Hellige, Inc., 3718 Northern Boulevard, Long Island City, N. Y.

"Bio-Filtration in Sewage Treatment" is featured in a new folder from Link-Belt Co. The system is made extremely flexible in combining high-rate bio-filtration through sprinkling filters with recirculation of filter effluent. The freshening return effluent is added to the crude sewage in any ratio found most desirable for the conditions at hand, thus affording a high degree of flexibility for seasonal requirements involving changing volume and, more particular, quality of the sewage to be treated. The folder explains briefly what bio-filtration is and how it works, in two schemes—single stage or double stage arrangement. The folder briefly describes and pictures several of the twenty odd bio-filtration plants now in operation. For a copy of Folder 1881 write Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Solution Feeders by International are presented in a bulletin just received from International Filter Company. Especially adaptable to the smaller plants, this particular chemical solution feeder is the Infilco MCO Feeder. It consists of a neat constant head box (pedestal mounted) equipped with a calibrated feed orifice of the Infilco design, providing micrometric feed control. The twin indicator dials actuated by the feed control knob makes positive settings simple and exact over operating ranges of 1 to 10 for each orifice—there being four orifices available to provide a complete range of 1.60 g.p.m. to 5.0 g.p.m. delivery. Exact specifications and detailed illustrations afford complete information on the feed control unit, solution tanks, and arrangements for solution delivery by gravity or to pump suction lines. For bulletin 302 write International Filter Co., 325 W. 25th Place, Chicago, Ill.

"Liquid Level Control" is the subject of a new bulletin devoted to Cochrane Valves for control of liquid levels in reservoirs, tanks (pneumatic or open types), hot water systems, etc. In all, five different methods of such control are presented, with valves for the purpose illustrated and described by specifications. Operating characteristics of these semi-balanced and pilot-actuated valves in sizes of 1 to 10 inches are recited. For Bul. No. 2939 write Cochrane Corp., 17th St. and Alleghany Ave., Philadelphia, Pa.

Plunger Type Sludge Pumps manufactured by Chicago Pump Co., are presented in a new and customarily well illustrated bulletin from this company. These sturdily constructed heavy duty pumps are manufactured in 1, 2 and 3 plunger models with a choice of silent chain or V-belt drives, with or without vari-drive motors. A feature claimed is the simplicity and multiplicity of out-put adjustments to meet requirements—11 changes

in rate being procured through simple stroke length adjustment. Detailed plans accompanied by full specifications reveal construction features almost at a glance. Installed units serving several plants are pictured, and amplify the full list of going installations and "satisfied customers"—some, in addition, having Chicago "Scru-Puller" Pumps for crude sludge pumping. For Bul. No. 195' "Plunger Type Sludge Pumps," write Chicago Pump Company, 2300 Wolfram St., Chicago, Ill.

"Progress in Sewage Chlorination" is revealed in a new Wallace and Tiernan Technical Publication which reveals the newest development in sewage chlorination control for effectiveness and economy — "Potential Chlorination." This control involves satisfaction of the chlorine demand to any desired or required degree *at all times* regardless of varying flows and changing chlorine demand of the sewage, waste or effluent. In articles, reproduced from Sewage Works Journal it is evident how such a control scheme insures adequate chlorination without wasteful chlorination which manual or automatic control according to flow alone does not avoid. The largest installation of "Potential Chlorination" is that at the main treatment plant of Syracuse, N. Y. For W. & T. Technical Publication No. 473, write Wallace & Tiernan Co., Inc., Newark, N. J.

"TEXROPE" Drives—by Allis-Chalmers—are presented by the Texrope Div. of Allis-Chalmers Mfg. Co., in a new 16-page illustrated bulletin, crammed full of facts and data essential in estimating costs, and selecting types and sizes of v-belt drive equipment. Besides including the latest revised ratings, it contains much information on Texrope belts, Texsteel, Texdrive and regular cast iron sheaves. Complete information is also carried on case iron adjustable and Vari-Pitch sheaves. Dimensions, horsepowers and speed range tables are shown for eleven sizes of Vari-Pitch Speed Changers ranging up to 75 hp. Features of the Texrope Drive are slipless and silent operation at 98.9% efficiency without need for belt dressing. This type of drive, operating on extremely short pulley centers, is space saving and productive of safety. Installation is simple and adjustments easily made. For Texrope Bul. B-6051-A write Allis-Chalmers Mfg. Co., Milwaukee, Wisc.

"Thermometers and Pressure Gauges" manufactured by The Brown Instrument Company are presented in a new catalog which covers the complete line of Brown Circular Case Thermometers and Pressure Gauges, Indicators, Recorders and Controllers. The seventeen features of construction of the Brown Electric Controller are illustrated, and principles of operation fully described. For a copy of Catalog No. 6705, write The Brown Instrument Co., Philadelphia, Pa.

Use P F T Equipment in Your Sewage Treatment Plant

Write for Latest Bulletins

PACIFIC FLUSH TANK COMPANY
Designers & Manufacturers of Sewerage and Sewage Treatment Equipment
4241 Ravenswood Ave. Chicago, Ill. — EXCLUSIVELY SINCE 1893 — 441 Lexington Ave. New York, N. Y.

NOW MORE THAN 125

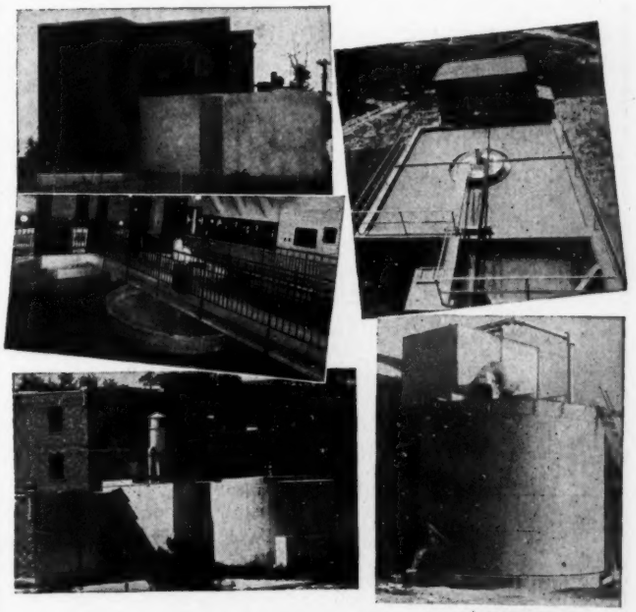
ACCELATOR

WATER CONDITIONING PLANTS

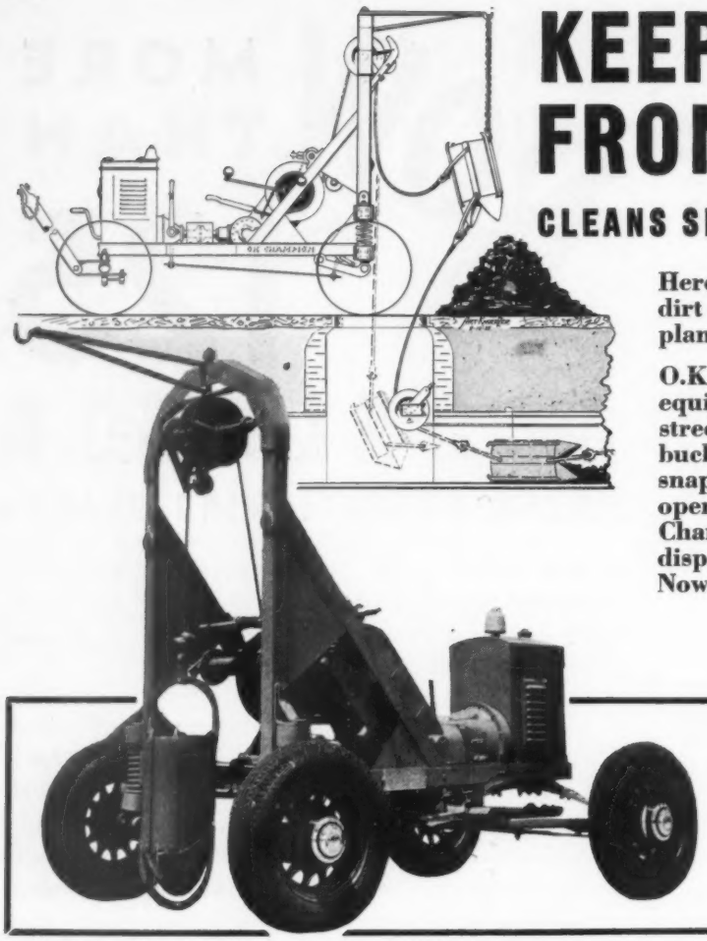
MORE THAN ONE HUNDRED TWENTY-FIVE Accelator plants for softening, clarifying and stabilizing were in service or under construction by August 1940!—60 in the last 18 months.

The constantly growing acceptance and enthusiasm for the Accelator treating process is significant, for it indicates wide-spread *earned* approval. Through *actual performance records* in scores of installations, the Accelator has established itself as the most efficient and modern type of water conditioning plant available.

***What* the Accelator is, *how* it operates and *why* it has so many advantages over conventional treating plants is told in Bulletins 1820, 1821 and 1822. Let us send you copies.**



INTERNATIONAL FILTER CO. INFILCO
325 W. 25TH PLACE, CHICAGO, ILL.



KEEP Needless LOAD FROM Disposal Plant

CLEANS SEWERS FOR LESS THAN 3c A FOOT

Here's the *RIGHT* way—the money saving way to get dirt and debris out of sewers. Protect your disposal plant—keep sewers open to full capacity.

O.K. Champion Power Sewer Cleaner is the only equipment that takes accumulation from sewer to street level *in one operation.* Traveling expansion bucket bites into blockade—and fills. Reverse pull snaps jaw shut. Bucket is then hauled to street and opened automatically. No flushing—no dipping. O.K. Champions save many times their cost by keeping disposal plants free from handling dirt and debris. Now used by Cities in over 40 States and Canada.

Complete Equipment for any size job—or city —from less than $500 up—Write for details.

O.K. Champion HAMMOND, INDIANA **POWER SEWER CLEANER**

CHAMPION CORPORATION

4715-35 Sheffield Ave. Hammond, Ind.

Motion Picture film 16mm showing OK. Champions in operation gladly sent to interested City Officials.

HEADQUARTERS

for

ZEOLITE WATER SOFTENERS
HOT PROCESS SOFTENERS
CHEMICAL PROPORTIONERS AND FEEDERS
WATER CONDITIONING
SWIMMING POOL ACCESSORIES
PRESSURE SAND FILTERS
OIL, IRON, TASTE, COLOR, AND ODOR REMOVAL FILTERS

and

LOW-RATE, HIGH CAPACITY AERO-TRICKLING FILTERS FOR SEWAGE PLANTS (HALVORSON-SMITH PROCESS)

●

LAKESIDE ENGINEERING CORPORATION

222 West Adams Street Chicago, Ill.

MONO-CAST CENTRIFUGAL PIPE USED EXCLUSIVELY IN PUMPING & PURIFICATION PLANT AT SPRINGFIELD, MO.

An impressive example of **"Acipco's" complete service** to the water works industry are the recently completed improvements to water facilities at Springfield, Mo., involving the installation of approximately 40,000 feet of 16", 20" and 24" Mono-Cast Centrifugal Pipe and several hundred tons of Mono-Cast B&S and Flanged Pipe & Fittings in various sizes. Mono-Cast Centrifugal Pipe are now available in diameters from 3" to 48", inclusive. Wide choice of joints for special purposes. Complete line of fittings. Write for literature.

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM, ALA.

NEW YORK CITY CHICAGO KANSAS CITY MINNEAPOLIS DALLAS LOS ANGELES SAN FRANCISCO PITTSBURGH CLEVELAND

EQUIPMENT NEWS

Light Weight Indestructible Ladders

● Two new aluminum ladders have recently been developed and placed on the market by the Aluminum Ladder Co. of Tarentum, Pa.

Constructed with steps on both sides, instead of on one side as in the conventional step ladder, the new ladders are especially valuable for use where two persons may use the ladder at the same time, and where ladders must be used in very narrow hallways and aisles. There are distinct advantages of being able to mount or descend ladders from either side.

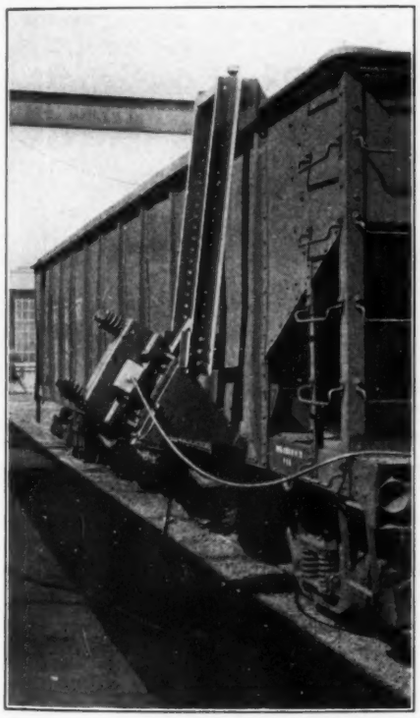
Both ladders are constructed throughout of a special aluminum alloy having a tensile strength of 48,000 lbs. per square inch. This material is practically indestructible and, of course, is much lighter in weight than most materials used in ladder construction. The ladder designated as No. 900 is 36" high, has a platform 12" by 15", yet weighs only 13 lbs. The feet are fitted with rubber pads for protection of floors.

The platform of ladder No. 901, constructed of treadplate for protection against slipping, is 19½" wide by 22" long and is 4 ft. above the floor. Safety rails rise 21" above platform. Its complete weight is only 40 lbs., but for ease in moving about the legs are mounted on casters.

For literature describing various styles of these handy aluminum ladders, write Aluminum Ladder Co., 394 Adams St., Tarentum, Pa.

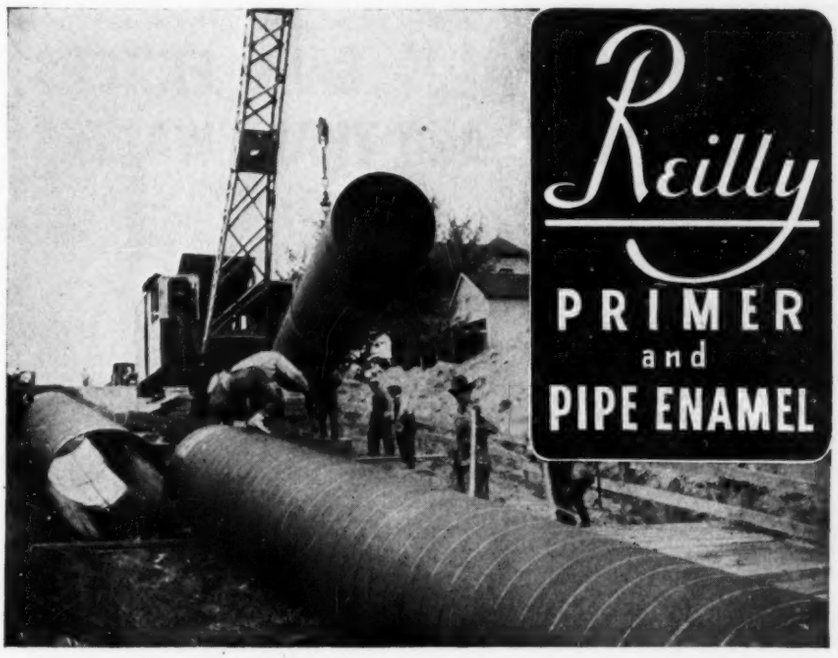
Giant Vibrators

● Syntron Co. has developed a new, large Vibrator for attaching to hopper bottomed railroad cars to speed up the emptying process. The Vibrators are huge pulsating electro-magnets striking 3600 times per minute. They are used in pairs, one being hung on each side but at opposite ends.



These Vibrators are also designed to be used, without the car hook, on big bunkers and storage bins to promote a free flowing discharge of material, and are designed for operation on 220 volt, single phase, alternating current. Initial installations have shown that two men working with two Vibrators can unload a car of fine coal quicker than 6 or 8 men can sledging and poking.

Additional information may be had from Syntron Co., 650 No. Lexington Ave., Homer City, Pa.



Protected INSIDE AND OUT

WITH REILLY PIPE PRIMER AND ENAMEL

For many years Reilly coatings have stood the test, providing dependable protection against rust and corrosion of water works and sewerage pipe, conduits, tanks, pumps and structural metal.

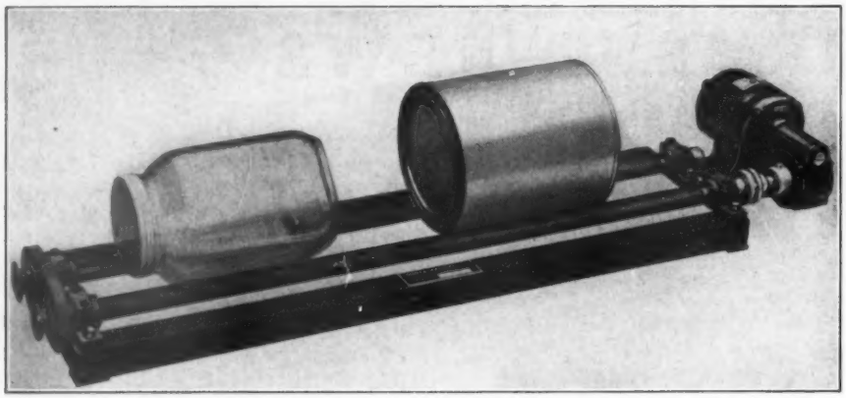
Inner surfaces are protected to prevent incrustation and tuberculation and to insure maintenance of full capacity flow, and outer surfaces are protected against the destructive action of corrosive soils and electrolysis. Reilly coatings are highly resistant to abrasion, and withstand wide variations in temperature without sag, chipping or peeling. They are economical to apply and constitute a sound investment.

REILLY TAR & CHEMICAL CORPORATION

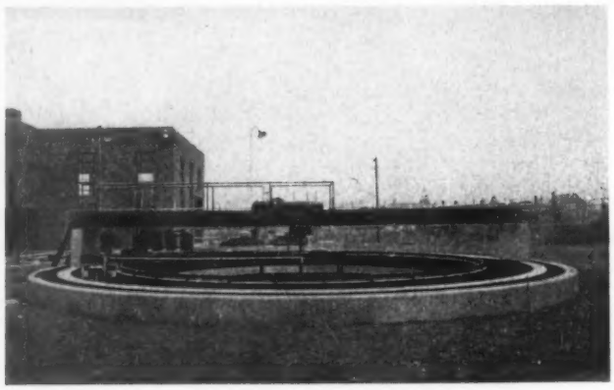
Executive Offices: Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS 500 FIFTH AVENUE, NEW YORK, N. Y. ST. LOUIS PARK, MINNEAPOLIS, MINN.

FIFTEEN · PLANTS · TO · SERVE · YOU



"MUNICIPAL" SAND FILTERS FOR SEWAGE AND TRADE WASTES



North Clarifier—Filter—South River, New Jersey

Municipal Sand cleaners are the only filter units that scour the sand and scrub the screen, removing bacterial growth.

Removal of suspended solids by filter 40 to 50%. Filter gives positive control of suspended solids in effluent and sedimentation period can be safely cut down, thereby greatly reducing cost of settling tanks.

In one revolution of the sand cleaner practically all of the trapped solids are removed from the sand. Unless these solids are removed bacterial growth on sand and screen soon plug the filter.

Installations at:

South River, N. J. — **Rutherford, N. J.**
Somerville, N. J. — **Sayreville, N. J.**
Raritan, N. J.

MULTI-ZONE FURNACES for incineration of sewage sludge, screenings and ground garbage
and
DRYERS—for sewage sludge and industrial products
Are other products of

UNDERPINNING & FOUNDATION CO., Inc.
155 East 44th St. — New York, N. Y.

OMEGA LABORATORY MIXER

Especially Useful in Making Marble Tests

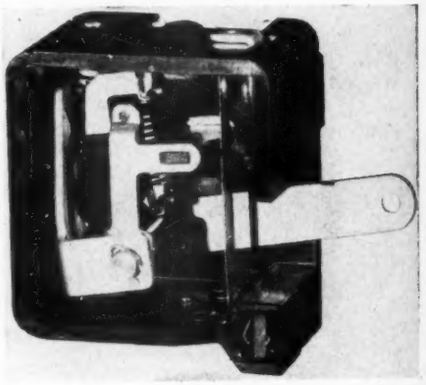
● A Laboratory Mixer of the jar-mill type has been developed by Omega Machine Company.

This mixer has a variety of possible uses in mixing or blending pulverent or granular materials or creating emulsions or fine suspensions. With the aid of pebbles it becomes a miniature pebble mill for grinding, colloiding or emulsifying.

The most apparent use to the majority of water works chemists will be its adaptation in performing the well known Marble Test in determining stability or corrosivity of waters and making of proper adjustments in anti-corrosion treatment or softening. In this test the powdered chalk is placed in the jars filled with the water sample (air excluded) and placed on the "cradle" formed by parallel rubber covered bars, and the motor is turned on. The two geared bars revolve in the same direction and roll the jars at the desired number of revolutions per minute. For stronger agitation square jars are employed to effect an up and down motion while being revolved.

Further details may be secured in a leaflet available from the Omega Machine Co., 4010 Penn Ave., Kansas City, Mo.

New "G.E." Float-Switch for Pumps



● A new float-switch designed specifically for sump-pump control was recently announced by the General Electric Co.

It is a single-pole switch employing an overcenter toggle mechanism. Float-rod weight is counterbalanced by a calibrated spring acting on the operating lever.

Other features include corrosion-resistant parts in the mechanism which permit operation under severe moisture conditions, accessible terminals for easy wiring, a dummy terminal to provide convenient wiring of the "through" side of the line, fine-silver contact tips, and snap-action mechanism. This new control simplifies the design of the sump-pump because of the fact that it is actually built for mounting in the motor end-shield or some suitable part of the pump. For further details write General Electric Co., Schenectady, N. Y.

A Hypo-Chlorinator at Less Than $100

● When a chlorinating unit can be had for less than $100 that makes news. And such is apparently now the case, as revealed in an announcement from %Proportioneers% Inc., namely, a "Chlor-O-Feeder" for $99.00 plus carrying charges. As far as we can determine there are no "extras" required for the ordinary installation.

This low price is set with the understanding that the purchaser makes his own installation from the instructions packed with the machine. In short, he does it himself. From this requirement the package of hypochlorinator and accessory parts is christened the "DU-SELF" Hypochlorinator. In return the customer is said to save roughly $100.

The announcement states that the important pumping head of the "DU-SELF" is an exact duplicate of the successful Heavy Duty Midget Chlor-O-Feeder.

Driven through a belt connection to the pump shaft, the unit keeps step with pumping rates. The "DU-SELF" is good for treating water volumes up to 25 g.p.m. against pressures up to 75 lbs. Speed limitations are set at 600 r.p.m. as the maximum for the pump or motor shaft belted to the hypochlorinator. The continuous span of operation is limited to a 5 hour maximum.

All of this is emphasized and apparently quite important. Aside from these limitations there are apparently no others to interfere with the one year guarantee of %Proportioneers%, who also offer subsequent service (shop or field) at the prevailing rates for servicing other Chlor-O-Feeders.

The announcement signed by Proportioneers President — Jeff Corydon — explains "This startling price reduction is in the interest of public health, and is so sound technically as not to risk our reputation gained in six years of pioneering pressure feed hypochlorination for small water works. Six years of mounting numbers of installations at a reasonable profit, and the pleasant knowledge that we have made chlorination grow—"

Those who would like more detailed information covering the new "DU-SELF" package, sales and service policy, etc., may have it by writing %Proportioneers% Inc., No. 9 Codding St., Providence, R. I.

New Process for Removing Silica

● As the culmination of research extending over a period of several years, The Permutit Company announces that it has perfected a commercial process for silica removal from boiler feed waters, thus preventing silica scale deposits in steam boiler, super-heaters and turbines. The process makes use of the silica-absorbing property of metallic oxide sludges. The water being treated is brought into the most intimate contact with high concentrations of sludge, thus assuring maximum silica removal. Soluble by-products are not formed; there-

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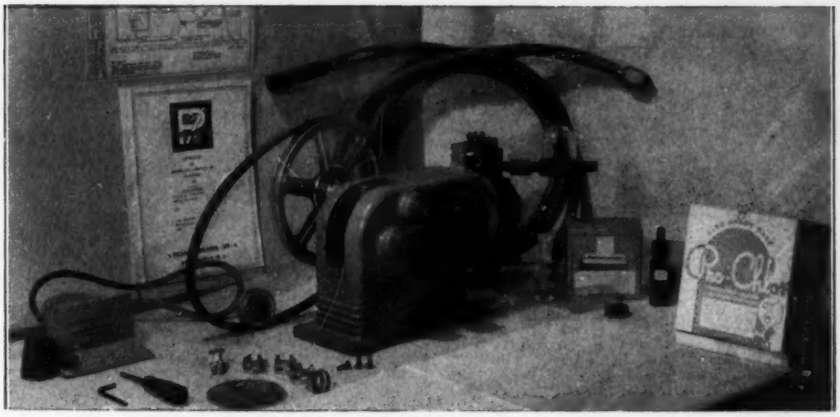
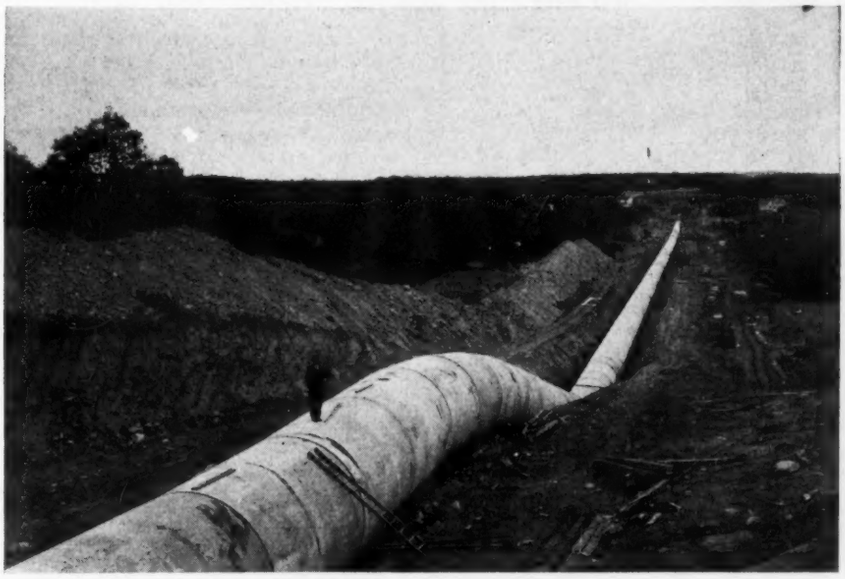


The DU-SELF, Accessories, Installation Sketch, Instructions in One Package



Boston, Mass.—A section of the 138" diameter Lock Joint Pressure Aqueduct.

Consider the Ultimate Cost when figuring pipe line costs . . . . .

The purpose of a water supply line is the transportation of water for future as well as present generations.

The most economical pipe line therefore is that one which will carry the greatest quantity of water for the longest time at the lowest ultimate cost.

True over all economy is determined by certain vital characteristics, all of which are included in every Lock Joint Pipe Line.

Consider then these proven facts about Lock Joint Pipe Lines in figuring pipe line costs:

Low first cost

Low Operating Cost—Due to permanently high carrying capacity resulting from smooth, permanent, concrete surfaces—Immune to tuberculation and corrosion.

Low Maintenance Cost — Due to negligible repairs and freedom from broken pipe or leaky joints.

Minimum Depreciation—Absence of deterioration in the many Lock Joint Pipe Lines now in service indicates that they may properly be regarded as permanent structures.

Lock Joint Reinforced Concrete Pressure Pipe Lines in addition to being low in first cost possess all of the essential requirements for permanently economical pipe lines.

LOCK JOINT *Reinforced Concrete* PRESSURE PIPE

LOCK JOINT PIPE CO. Established 1905 AMPERE, N. J.

THE NEW

ATLANTIC

PNEUMATIC

PIPE DRIVER

Pays for itself on the first job

Universal Joint between driving head and shank widens working angle, simplifies driving in small spaces.

DRIVES PIPE UNDERGROUND 25 Ft. an Hour!

Up to 2" pipe through ordinary soil. Drives under highways, abutments, lawns, etc., without excavating No delay coupling added lengths; no burring pipe ends.

NO TRENCHING, BACKFILLING, OR SURFACING

TAKES POWER FROM STANDARD PAVING BREAKER!

SEE OUR Exhibit at the N.E.W.W. Ass'n Convention

A SIZE FOR EVERY SERVICE!

Only 3 parts: Driving point, driving head, driving shank. Weighs only 8 lbs. Standard sizes fit from 1" to 2" standard pipe. Special sizes for extra heavy pipe. Shanks fit standard pavement breakers. Lasts for years. Pays dividends over and over again. Acme of simplicity and low cost!

Made from Select Steel, Specially Heat-treated to Withstand Heavy Blows.

ATLANTIC STEEL COMPANY

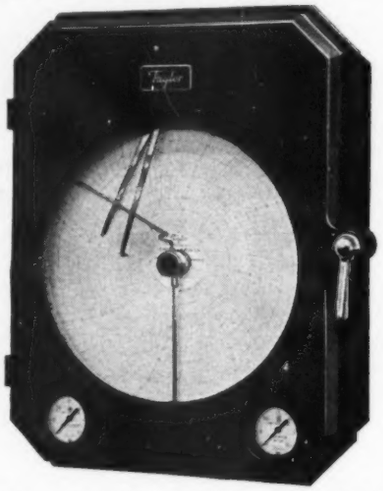
1775 BROADWAY, NEW YORK

fore, the total dissolved solids in the feedwater is not increased but is usually reduced.

The process is now in successful use and reported operating costs are low. It can be used in connection with both hot and cold lime soda processes of water softening and is adaptable to either new or existing equipment. For a bulletin explaining this novel process in detail write The Permutit Co., 330 W. 42nd St., New York, N. Y.

New Line of Taylor Recorders

● To provide truly companion recording instruments for their completely redesigned line of Fulscope Controllers, the Taylor Instrument Companies, Rochester, New York, have just released their new recorders for temperature, humidity, pressure, load, rate of flow, liquid level, etc. Exclusive of the controller mechanism, the recorders and recording controllers are identical. Even the cases are drilled and tapped to receive any of the five standard Fulscope control mechanisms should it be desirable to add it at a later date.



The new universal case is for both face and flush mounting. It can be mounted on panels side by side with the previous Taylor recorders because the same dignified lines and pleasing proportions are retained. Dust and moisture are sealed from the case by Neoprene door gaskets and a positive bayonet-action latch.

The time previously required for changing charts is cut in half by a uniquely designed mechanism that combines the chart locking device and pen lifter. The chart is easily removed and replaced with one hand.

A die-cast aluminum chart plate gives a rigid surface for pencil notations on chart and for carrying the chart clamp and pen lifter. Available with 10" or 12" charts, and with one, two or three pens, hundreds of standard chart ranges are available for selection.

Bourdon actuating springs, used with temperature and pressure systems, possess the same great strength and durability as in former instruments. And, stainless steel for links, pivots and pen arms is employed to assure long life, minimum effect of vibration, and accurate, clean-cut pen records.

Amongst additional features are a new electric chart clock, with improved coil de-

A BLUE RIBBON Jointing Compound!

It's sulphur-base—*Tegul*-MINERALEAD. Leaks heal almost immediately, enabling you to meet any reasonable leakage specifications. You can backfill trenches and clear up premises at once ● Easiest ever to handle, ship and store, because it comes in 10 lb. ingots ● Those ingots save trouble when rain, snow or floods come along, for water runs off them as off the old duck's back. There's never a worry about their being stored in the open, if weather turns bad ● And they make permanently tight, trouble-free joints, with far above average resistance to mechanical and thermal shock ● The *cost*? That, too, will be a pleasant surprise ● Write for further information. The ATLAS MINERAL Products Company of Pennsylvania, Mertztown, Pa.

Tegul-MINERALEAD

HAPPY DAYS

THEORY vs PRACTICE

"It Does All You Claim."

"We are ordering our second Palmer Filter Bed Agitator," says a water works superintendent (name on request).

One large plant last week just ordered 31 Palmer Filter Bed Agitators (name on request).

PALMER FILTER BED AGITATORS

- **eliminate mud balls**
- **reduce wash water 40%**
- **lengthen filter runs**
- **keep the sand as clean as new sand**

Let us explain why the high pressure action of the Palmer Agitator is correct in practice and in theory.

ACTIVATED ALUM CORP.

P. O. Box 209

CURTIS BAY BALTIMORE, MD.

sign, totally enclosed oil-immersed gears, and slower speed motor which give longer life. There is available an explosion-proof type for hazardous atmospheres. For further details and literature write Taylor Instrument Companies, Rochester, N. Y.

F.-M. Mixed Flow Pumps

● Fairbanks, Morse and Co. announce a new line of improved pumps of the so-called Mixed Flow type for lifting relatively large volumes of sewage, drainage, cooling water, storm water, or raw water for treatment, against moderate heads.

Their principle advantages are low cost and trouble free operation at high efficiencies. They operate with the propeller submerged and may be suspended in a simple manner from a floor or from structural members above the water to be pumped.

The new F-M Figure 6360 pumps are being offered in several capacities up to 60,000 g.p.m. against a 40 ft. head, but are available for the smaller jobs also. Since this type pump requires no priming it is especially adaptable to automatic start and stop operation.

This line of pumps are effectively presented in F.-M. Bulletin 6360. For a copy write Fairbanks, Morse & Co., Chicago, Ill.

Improved "Flextite" for Stopping Leaks

● Flexrock Co. has developed a new active ingredient which, used in their FLEXTITE, brings its activity down to a measure of seconds instead of minutes.

This new FLEXTITE is used with ordinary portland cement and if forced against water pressure, and held there only a few seconds, the leak is stopped. It is therefore offered for stopping leaks in dams, retaining walls, reservoirs, concrete tanks and basins. It is also valuable for water-proofing and damp-proofing generally in cellars or basements, in pits, tanks, and other such places. Details concerning this new, more active material may be obtained by writing FLEXROCK Co., 23rd and Manning Sts., Philadelphia, Pa.

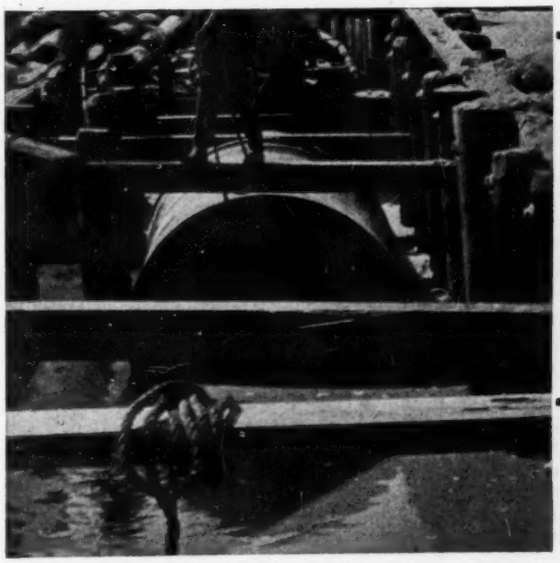
WRITE TODAY FOR THIS INFORMATIVE FREE *28-Page* BULLETIN *No. 602!*

A study of this bulletin would be to your best interest, as it would enable you to form an intelligent judgment as to what is best suited for a particular purpose in extending present equipment or in planning for an initial installation.

PERPETUALLY ACCURATE GLASS COLOR STANDARDS
NOW AVAILABLE FOR

pH Control, Color of Water, Ammonia Nitrogen, Nitrite Nitrogen, Nitrate Nitrogen, Chlorine, Iron, Dissolved Oxygen, Manganese, Lead, Phosphate, Silica, and Sulphides.

HELLIGE, INC. 3718 NORTHERN BLVD. LONG ISLAND CITY, N.Y.
HEADQUARTERS FOR COLOR STANDARDS AND COLORIMETRIC APPARATUS



84" pipe—Spring Lake, N. J.

FLANGED PIPE
FLEXIBLE JOINT PIPE
BELL & SPIGOT PIPE
SPECIAL CASTINGS
SHORT BODY BELL & SPIGOT SPECIALS

Large stock enables us to make prompt shipments.

CAST IRON PIPE

SIZES 2" TO 84"

Warren Foundry & Pipe Corp.
11 Broadway, New York

Warren Pipe Company of Mass., Inc.
75 Federal St., Boston

When You Specify

Meters and Recorders

Be Sure To Demand

•ACCURACY •RELIABILITY
•SOUND ENGINEERING
•MODERN APPEARANCE

Regardless of whether your problem calls for the use of a Venturi Tube, Weir, or Flume, you can depend on Bailey Meter Company to design and construct both the primary element and the register for maximum accuracy.

A vast amount of experience gained from thousands of installations of metering equipment, together with extensive experimental work in our own hydraulic laboratory and in the laboratories of the Ohio State University, Cornell University, Case School of Applied Science and other institutions, is back of every Bailey Primary Element.

The reliability of Bailey Meters and Recorders is attested to by the fact that thousands of dollars worth of steam and water are sold monthly and billed solely on the basis of readings from Bailey Meters.

No small share of the accuracy and reliability of Bailey Meters is due to the conservative engineering policy of the Company. New ideas and designs are not offered for sale until they have been thoroughly tested both in the laboratory and in actual service.

Bailey Meters, Recorders and Controllers present a thoroughly modern yet conservative appearance.

Write for your copy of Bulletins No. 301 and 302, describing Bailey Fluid Meters for steam, liquids, gases, sewage, sludge, and compressed air.

MU-16

BAILEY METER • COMPANY •

1072 Ivanhoe Road, Cleveland, Ohio

BAILEY METER COMPANY LTD., MONTREAL

New MSA Explosimeter

● Mine Safety Appliances Co. have announced an improved model of the "Explosimeter" combustible gas indicator.

The Explosimeter Model 2 is compact, strongly built and light in weight, with a simplified electrical circuit featuring a single filament and single control knob.

True one-hand operation of the instrument is an outstanding advantage—one hand is left entirely free to handle sampling line or probe. Immediate response to combustible gas concentrations is provided by the instrument's easy-reading meter, with positive reading on second squeeze of bulb (5 ft. sampling line). The flow system is cast integral with case, without tubing or connections to leak, and a built-in filter chamber is provided to trap dust and moisture. This filter chamber will also accommodate a charcoal cartridge for proper differentiation between illuminating gas and combustible vapors, such as gasoline.

The new Explosimeter is powered by standard flashlight batteries contained in a separate compartment from the working parts. The batteries are entirely isolated from working parts of the Explosimeter.

Another interesting feature is the On-Off Signal Bar on the single control knob, which is raised prominently in view when current is turned on, and drops flush with the knob when current is switched off,—thus preventing the user from unknowingly leaving the instrument with current on.

While the low-cost replaceable single filament used in Model 2 has a normal useful life of several thousand tests, a spare is contained in the case ready for instant use. It may be changed as easily as a light bulb.

This simplified combustible gas indicator is described in detail in Bulletin No. DN-4. For a copy write Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.

Improved Duplex-Type Chemical Pump

● An opposed-type Duplex Chemical Pump, with capacity up to 4 gallons per hour against a pressure up to 3,000 lbs. is now being offered by Milton Roy Pumps, of Philadelphia. Only one hp. is required and the explosion-proof, geared motor and pump are an integral unit of exceptionally compact design. Double-ball check-valve on pump chambers is an exclusive feature of this pump.

IF Your Sewage effluents are high in suspended solids;

Or, you have a Water Problem;

Or, desire to Recover a product now wasted;

Or, you are disturbed by Stream Pollution;

Or, are in any way interested in the removal of suspended solids from liquors;

You should investigate the

Laughlin Modified Rapid Sand Filter

BECAUSE, it is a simple automatic, continuous flow apparatus, designed on familiar lines, to accomplish a purpose without adding to the operator's troubles.

LAUGHLIN EQUIPMENT CORPORATION

270 Madison Ave., New York City

HYDRO-TITE

A DEPENDABLE self-caulking joint compound used to joint cast iron bell and spigot pipe. Much easier to use than lead and makes stronger, more flexible and tighter joints.

Employed on thousands of miles of pipe from 4" to 60". Write for our free trial offer.

HYDRAULIC DEVELOPMENT CORPORATION

MAIN SALES OFFICE 50 CHURCH STREET, NEW YORK
GENERAL OFFICES AND WORKS - WEST MEDFORD STATION BOSTON, MASS

OVER 25 YEARS WITHOUT A FAILURE

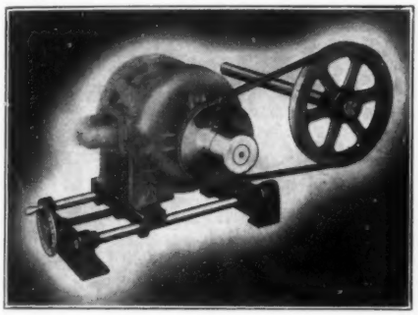
it is stated that this step-valve construction not only eliminates air-binding but also automatically discharges small particles of dirt and makes pumps self-cleaning. Pump plungers, ball checks and ball seats are all of stainless steel.

Milton Roy pumps, well known in the chemical industry, are employed for handling alkalies, sulphuric acid, ferric chloride, hypochlorite solutions, hydrochloric and phosphoric acids and various other liquids and chemicals. They are used also for pumping two or more chemicals simultaneously, or on separate feed to two or more points of delivery.

For further details or literature write Milton Roy Pumps, 3160 Kensington Ave., Philadelphia, Pa.

Reeves Vari-Speed Jr.

● Reeves Pulley Company announces an addition to its extensive line of variable speed control equipment. Reeves new Vari-Speed Jr. has been introduced to bring dependable speed control to even the smallest and lightest machinery.



By means of this low-cost unit, any standard constant speed motor of from fractional to 1½ hp. is easily and inexpensively converted into a variable speed unit to provide complete speed adjustability. No special shaft extension is required. Speed variation is "infinite" within the limits of the unit—that is, a countless number of operating speeds is available without "steps" or "jumps"—and is accomplished while the machine is running.

The Vari-Speed Jr. comprises a disc assembly and adjustable motor base. The well known Reeves disc assembly consists of two cone-shaped discs (one stationary and one laterally adjustable), a self-adjusting tension spring, a spring adjusting nut and cover. By means of an adjusting handwheel, the motor is moved forward and back. When nearest to the driven sheave, the V-belt runs over the largest diameter on the discs and maximum speed is secured. Reversing the handwheel moves the motor away from the driven sheave, the V-belt runs over smaller diameter on the discs (the adjustable disc moving out to accommodate the belt), and speed is reduced.

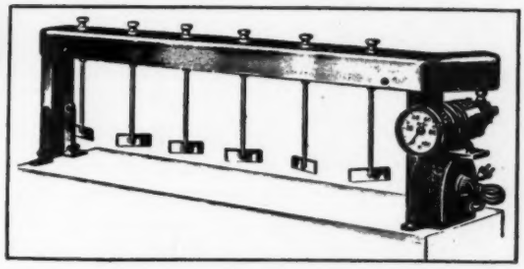
The Vari-Speed Jr. is built in six different sizes of disc assembly, for use with motors of from ⅛ to 1½ hp. and provides speed control over a range of from 1¾:1 to 2¾:1, inclusive. For additional illustrated details write, Reeves Pulley Company, Columbus, Indiana.

GOOD MIXERS . . .

in the

WATER WORKS FIELD

"Bob" Haywood of Industrial Chemical Sales—"Fred" Stuart, President, Activated Alum Corp.



THE *Phipps & Bird* LABORATORY MIXER...

IS the important piece of equipment in the Modern Water Works Laboratory. Now being used by leaders in water works research. Many superintendents and chemists have been able to reduce their chemical costs by the control of this mixer—dry feed machines adjusted accordingly.

The Phipps & Bird Laboratory Mixer makes longer filter runs possible, together with reducing wash water consumption. All alert Water Works Superintendents and Chemists should "tie" in this Mixer with modern plant practice.

Send for Literature

PHIPPS & BIRD, INC.

RICHMOND, VA.

"SOUTHERN CENTER FOR LABORATORY APPARATUS AND CHEMICALS"

Bell & Spigot **Flanged**

Cast Iron Pipe and Fittings

FOR

BAIN FILTER PLANT

AND

ADDITIONS TO DISTRIBUTION SYSTEM

IN

RALEIGH

FURNISHED BY

Glamorgan Pipe & Foundry Co.

LYNCHBURG, VIRGINIA

Introducing

WHITE vs BLACK FOR TASTE and ODOR CONTROL

Activated's Bleaching Clay brings a **white material** to the taste and odor control field.

Norfolk has just switched over to Bleaching Clay saving 60% of its former taste and odor control treatment costs. (Story in "Activated Alum News" — August issue.)

With such cities as Atlanta, Ga.—Chester, Pa.—Norfolk, Va., among others using it, the same material should do the same for you.

Why not investigate our plant-scale trial proposal at no obligation. (The average delivered price per ton in carloads is $20.50—**and it's white instead of black.**)

ACTIVATED ALUM CORP.

P. O. Box 209

CURTIS BAY **BALTIMORE, MD.**

REAL SURFACE PROTECTION

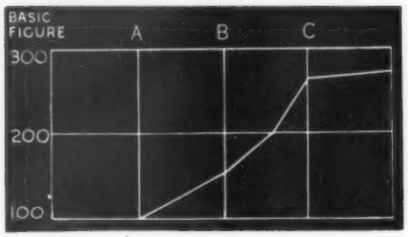
with **SHERWOOD'S** specifications is **ECONOMICAL, EFFECTIVE** and **DURABLE**

R S P ASPHALT EMULSION FOR ROOF COATINGS
R S P SEMI-MASTIC FOR NON-SLIP FLOORS
R S P PLASTIC FOR EXPANSION JOINTS AND CAULKING

THEY ARE NOT COAL TAR PRODUCTS

Special instructions are gladly supplied for the many uses for these exceptional products. We invite your questions on waterproofing problems of any nature and assure you of our cooperation.

SHERWOOD WATERPROOFING CORPORATION
53 PARK PLACE NEW YORK, N. Y.



VACUUM FILTERING COSTS LOWERED

To ascertain which is more economical, a series of plant runs was conducted, using three different coagulants. Carefully kept records covered:

Weight of Wet Cake
Per Cent Solids
Pounds Dry Cake
Solutions Used in Inches
Pounds per Inch
Total Pounds Used (Anhydrous)
Per Cent Used to Dry Solids
Costs

. . . . and here is the record of Filter Yield:

Material	"A"	"B"	"C"
	7.53 lbs.	6.74 lbs.	5.38 lbs.

per square foot per hour

Setting cost of **ISCO FERRIC CHLORIDE** (Material "A") at 100—the cost of other materials proved to be:
Material "B" 151 Material "C" 254

ISCO FERRIC CHLORIDE cost
51% less than "B" 154% less than "C"

Doesn't this suggest that you should write at once for more information about

ISCO FERRIC CHLORIDE

INNIS, SPEIDEN & CO.
117 LIBERTY STREET, NEW YORK, N. Y.
Chicago Cleveland Boston
Philadelphia Gloversville, N. Y.

PHOENIX
DISC WATER METERS

MANY YEARS OF
DEPENDABLE ACCURATE SERVICE

WITH SPIRAL GEARS
A
PATENTED FEATURE
IN PHOENIX METERS

ALSO

METER REPAIR PARTS

Send inquiries for prices and samples. We furnish Parts for Union King Meters.

PHOENIX METER CORP.
Prince Bay, S. I. New York, N. Y.
Established 1914

EDSON'S NEW HAND PUMP

Smallest Diaphragm Pump Made, 2" Suction Open Discharge. Capacity 1400 G.P.H. Weight 50 lbs.

THE EDSON CORP'N
49 "D" Street
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NEW YORK: 142 Ashland Pl., Brooklyn
CHICAGO: 1061 Peoples Gas Building

Catalog "T" Gives Full Data, Also Edson Hand and Power Pumps, Suction Hose and Pump Accessories

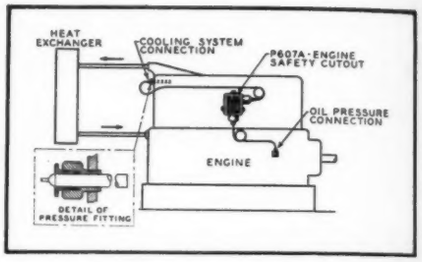
STOP CORROSION
with CARSON MECHANICAL JOINTS
● **CHARCOAL IRON BOLTS** ●
for Cast Iron Pipe and Fittings

WRITE FOR PRICES AND FURTHER INFORMATION

CARSON CADILLAC CORP.
1221 PINSON ST. BIRMINGHAM, ALA.

Engine Safety Cutout

● Here is an interesting new safety device designed to protect stationery internal combustion engines by interrupting their operation if the lubricating oil pressure drops hazardously low or if the cooling water temperature rises too high.



It provides an inexpensive insurance against costly damage to expensive engines and is particularly essential on engines that operate for long periods of time unattended, such as is frequently the case in water and sewage plants.

Combining in one device the duties of two controls, the manufacturer lists the following distinctive features posessed by this interesting safety instrument:

1. Universal application — For engines with a distributor type of ignition the device is wired to break circuit on temperature rise or pressure fall. For engines with a magneto type of ignition the opposite terminals are used which short circuits the primary of the spark coil to the ground. For Diesel engines the device is set up to control a solenoid valve installed in the fuel line to the injection system.
2. Elimination of a manual reset latch to keep the reset button depressed is an added safety feature; because, if the motor is started and the oil pressure does not build up, the motor will stop as soon as the operator takes his finger off the reset button.
3. The temperature element capsule can be inserted in any ½" pipe tapping in the block. Its size is only 4 x ½". And there is no separable well to install, special packing gland being furnished.
4. A mercury switch (S.P.D.T.) handles the switching action, thus increasing clean contacts and dependable positive switching action at all times.
5. The instrument is compact—being only 6⅛" in height, 5-9/16" in width and 2-11/16" in depth.

For literature setting forth details write the Minneapolis-Honeywell Regulator Co., 2950 Fourth Av., South, Minneapolis, Minn.

SECURE

Control of
Aquatic Plant Life
with

BENOCLOR 3

TASTE, ODOR & COLOR

Depend on
This Factor

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Write for Literature

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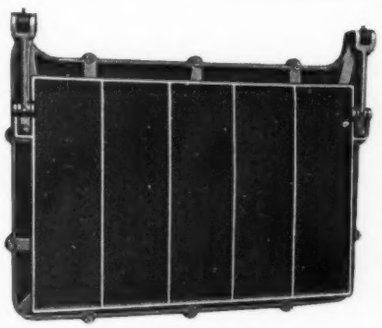
Cloroben Corp.

90 FORREST ST.
JERSEY CITY, N. J.

TIDE GATES



TYPE M-M

Type M-M Tide Gates are extremely sensitive; are made of all metal construction; frames and shutters are normally made of cast iron; seating surfaces are accurately machined; hinges are of link type which hang from adjustable lugs; lug adjustment provides means to secure correct seating even though foot walls are slightly out of plumb. Type M-M gates are available for heads of 12', 20' and 40' head. Recommended especially for conditions of normally free discharge.

TYPE M

Type M Tide Gates comprise circular designs. Also available in Type M-C which provides shutters of cellular construction.

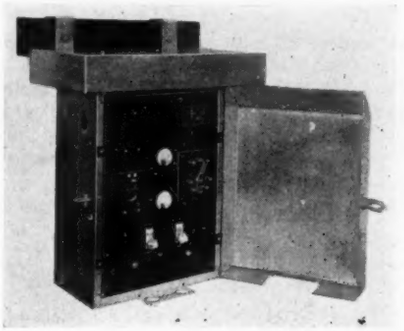
Bulletins upon request.

BROWN & BROWN, Inc.

LIMA, OHIO

Rexselen Cathodic Corrosion-Eliminator

• The Rexselen Cathodic Corrosion Eliminator is a complete rectifier and control assembly especially designed for cathodic protection of pipe lines, tanks and submerged metal structures.



The Rexselen Cathodic Corrosion Eliminators embody Selenium Rectifier Stacks. They are said to require exceptionally little maintenance throughout a long service life. Because of stability of output, visits by an attendant are necessary only to determine and adjust current to new requirements.

The power efficiency factor of Rexselen Eliminators is very high, ranging between 60 and 80% depending upon the voltage and current output. An important feature listed by the manufacturer is that high efficiency is sustained throughout long lift of the rectifiers. There are no moving parts to wear out, the rectifiers consisting of rigid discs.

The Rexselen Eliminator illustrated (Type CB) is rated at 8 volts, 50 amps. D.C. and is for operation on single-phase A.C. supply. It measures only 28" high, 21" wide, and 15" deep, and weighs only 110 pounds. Other Type CB units are available in higher and lower current capacities. All are adjustable to rates of 50% or less of their full-rated voltage.

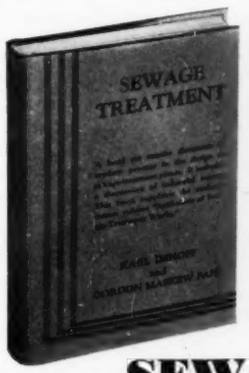
The control panel of the Eliminator is equipped with A.C. magnetic circuit breaker with time delay, ammeter and voltmeter, tap changing link switch, and solderless D.C. terminals. The new Type CB Eliminators are equipped with the Thermotrol, an exclusive device for protection against overloading or operation in abnormally high air temperatures. The rectifier and auxiliary equipment are built as a unit and mounted in a ventilated weatherproof steel cabinet designed for out-of-door mounting on a pole or wall. Indoor models can also be furnished.

For illustrated literature describing this unit in greater detail write Electrical Facilities, Inc., 4224 Holden St., Oakland, Calif.

SO YOU'RE GOING TO ST. LOUIS! STAY AT
Hotel Lennox
IT'S RIGHT DOWNTOWN. GOOD PARKING... AND MAN, WHAT SERVICE!
ALL ROOMS WITH BATH—RADIO RECEPTION

Workable, detailed information on the actual problems of sewage treatment—

Disposal of other wastes with sewage . . . Principles of flotation processes . . . Handling and storing of chemicals . . . Properties and costs of chemicals used in sewage treatment . . . Collection, storage and utilization of sludge gas . . . Location and design of outfall works . . . Methods of aeration . . . Design of digestion tanks . . . Odor prevention and destruction . . . Cost of sewage treatment . . . Economic and agricultural utilization of sewage . . . Chlorine requirements for disinfection of sewage . . . Heat requirements of sludge incinerators . . . Cost of treating industrial wastes . . Deoxygenation of receiving waters, etc.



SEWAGE TREATMENT

By KARL IMHOFF and GORDON MASKEW FAIR

Practical, non-mathematical data on the entire range of modern sewage treatment

In this compact volume two eminent authorities present briefly and simply the considerations and calculations that enter into the design and operation of modern sewage treatment plants. This is a practical book for operators of sewage treatment works, civil and sanitary engineers, sanitary chemists, and others in allied fields.

Published July, 1940

370 pages **5¾ x 8** **$3.00**

ON APPROVAL COUPON

John Wiley & Sons, Inc.
440 Fourth Avenue, New York, N. Y.

Kindly send me a copy of **IMHOFF and FAIR'S SEWAGE TREATMENT**, on ten days' approval. At the end of that time, if I decide to keep the book I will remit **$3.00** plus postage; otherwise, I will return the book postpaid.

Name .....
Address .....
City and State.....
Employed by .....

WWS-9-40

GASKET AND FORM
The Perfected Method for Making SEWER PIPE JOINTS OF CEMENT

- No jute used—gasket centers spigot.
- Definite space in each joint for cement.
- Form confines cement-grout to lower portion of joint.
- Particularly advantageous in water-bearing trenches.
- Infiltration minimized.

L. A. WESTON **Adams, Mass.**

Prevent wear and cutting of rods, plungers, shafts and valve stems by using

MABBS RAWHIDE PACKING

In Your Water Works and Sewage Plants

IT LASTS LONGER — *Is Anti-Frictional, Saves Power, Labor and Repairs. Will prove the cheapest packing that can be bought.*

Trade Mark Reg. U. S. Pat. Off.

Mabbs Hydraulic Packing Co.
Incorporated 1892
431 S. Dearborn St., Chicago, U. S. A.

CAST IRON PIPE

The Standard Material
for
Underground Mains

THE CAST IRON PIPE RESEARCH ASSOCIATION

Thomas F. Wolfe, Research Engineer
1015 Peoples Gas Bldg. Chicago, Ill.

The Meter-Master

RATE RECORDER FOR WATER METERS

Send For Literature

F. S. BRAINARD & CO.
246 Palm Street, Hartford, Conn.

WITH THE MANUFACTURERS

New Chlorine Handling Safety Chart

● Mathieson Alkali Works, Inc., who some years ago conceived the idea of distributing to their customers a "Chlorine Safety Chart" for posting wherever liquid chlorine is handled or used, found that this method of educating men in safe and unsafe methods of handling chlorine, of dealing with leaks and of first aid remedies, paid handsome dividends in the form of accident prevention and property protection.

Now Mathieson has issued a new 1940 edition of the Chlorine Safety Chart here pictured.

It is neatly and attractively set up in green and black with cuts of the valves used on the three standard types of chlorine containers. The detailed schematic representation and careful labeling of the valve types greatly enhance the value of the chart as a whole.

The essential requirements in the safe handling of Liquid Chlorine are outlined in the form of twenty-four suggestions. This subject matter is subdivided under the headings: handling containers, gas masks, chlorine leaks, and first aid measures. The material, while not intended to cover every possible contingency, is considerably more complete than anything of a similar nature available, incorporating as it does new suggestions on the storage of containers, the handling of containers and valves, the stopping of leaks, and the effective use of gas masks.

The chart, which reflects the wide experience of the producer, may be had for no more cost or trouble than that of mailing a request to The Mathieson Alkali Works, Inc., 60 East 42nd St., New York, N. Y.

Robinson Clay to Build $750,000 Plant Will be Largest Clay Pipe Plant in America

● Announcement of a new three quarter million dollar clay sewer pipe plant to be built at Pottstown, Pennsylvania, has been made by H. B. Manton, President of The Robinson Clay Products Co. of Akron, Ohio.

According to the announcement the new Pottstown plant will be the largest and most modern clay sewer pipe plant in the country. Production will begin early next year, with an annual capacity of 75,000 tons of vitrified clay sewer pipe and other clay products.

The Robinson Clay Products Co., sewer pipe producers since 1856, has pioneered many improvements in manufacturing clay products and now announce a new manufacturing process, which is stated to be one of the most important developments in the clay sewer pipe industry.

Although this greatest of all the Robinson plants is to be in Pottstown, Pa., the executive offices of the company will remain in Akron, Ohio.

Northrop Co. to Sell Schramm Compressors

● Schramm, Inc. have just announced the appointment of Northrop and Company, Inc. of 50 Church Street, New York City as distributors in the water works and sewerage fields of Schramm Compressors and other Schramm equipment.

This company, with its wide experience and knowledge in these fields, should prove most successful in marketing Schramm Compressors.

Chain Belt Moves to Larger Quarters in Minneapolis

● Chain Belt Co., well known manufacturers of "Rex" water works and sewerage equipment, announces the removal of its Minneapolis office from 808 LaSalle Avenue to 1645 Hennepin Avenue. At the new address, the company will have a much larger space and increased service facilities.

Mr. R. X. Raymond, who has been associated with Chain Belt Co. for over twenty years, continues as Minneapolis District Manager.

FOR DITCHING JOBS
If you have a ditching job, this P&H Multi-Service Crawler Hoist for backfilling and pipe handling is a real bargain. Triple drum arrangement gives it unusual flexibility. Maneuvers smoothly. Send for Bulletin X-39.
Address Box No. 90
Water Works and Sewerage
330 South Wells St., Chicago, Ill.

Sales Engineer: Thoroughly experienced in Industrial and Municipal sales field open for connections in these fields, particularly in the water and sewerage disposal equipment departments of makers of this type of equipment. Address "I.N.G." of "Water Works & Sewerage," 155 E. 44th St., New York City,

RUSTA RESTOR

An effective and low cost method of preventing corrosion in water tanks.

RUSTA RESTOR will prevent further corrosion of underwater surfaces. Effective whether tank has been painted or not.

No need to shut down tank. The most effective and economical method of water tank protection.

Write today for details

RUSTA RESTOR CORP.
1480 W. State Street
FREMONT, OHIO

LEADITE

The Pioneer Self-Caulking Material for C. I. Pipe

"ALL THIS HAS BEEN DONE, USING LEADITE."

Diameter of Pipe	Quantity of Pipe Laid
6"	98,232 ft.
8"	37,199 ft.
10"	2,935 ft.
12"	1,310 ft.
14"	324 ft.
16"	7,708 ft.
36"	37 ft.
Total	147,745 ft.

THE LEADITE COMPANY
Girard Trust Co. Bldg., Philadelphia, Pa.

No Caulking

Simplex Now Represented by Luippold in So. California and Arizona

● Simplex Valve and Meter Company have just announced the appointment of the Luippold Engineering Sales Company, 1115 South Hope Street, Los Angeles, as exclusive representatives for the Simplex Valve & Meter Company in Southern California and in Arizona.

For a good many years, G. T. Luippold, President of Luippold Engineering Co., was District Manager for Wallace & Tiernan Co., in the same territory. He left to go into business for himself as sales representative for several equipment manufacturers.

This announcement has come from Everett M. Jones, Sales Manager for Simplex Valve & Meter Co., Philadelphia.

$1,000 Contest Announced by Clow-National

● "You may have a prize winning idea," is the title of a folder recently distributed to water works superintendents, engineers and contractors, describing the Clow-National $1,000.00 Contest for "A Better Pipe Economy."

In this move, James B. Clow & Sons, of Chicago, and their affiliate, National Cast Iron Pipe, of Birmingham, are going directly to the men who use their products for suggestions for improvement of present products, for new products, and for new uses. They explain—"It is in the field and on the job that the "short cuts" are discovered; that the need for a gapfilling item is felt; or that the desirability of improvement in present products is made evident."

An incentive to send in such suggestions is offered in the prize awards, which consist of a First, Second, Third and 100 Honorable Mention Prizes. The judges in the contest, which closes December 7, 1940, are well-known water works men, being Bernard J. Cullom, Supt. of Water Pipe Extension, Chicago; Wesley Polk, Commissioner of Public Works, Evanston, Illinois; and Jack A. Byers, Vice President, James B. Clow & Sons.

All who may be interested in entering suggestions should write for a copy. Address Frank J. Egan, Manager of Cast Iron Pipe and Foundry Dept., James B. Clow & Sons, 201-299 North Talman Avenue, Chicago, and a copy of the folder will be sent promptly.

Sterling Pump Buys Roots-Connersville's Turbine Pump Business

● Announcement has been made by the Roots-Connersville Blower Corp. (Connersville, Ind.) of the sale, effective September 1st, of its Turbine Pump business consisting of water systems, condensate units and turbine pumps for general industrial applications to the Sterling Pump Corp. of Hamilton, Ohio.

Sterling Pump Corp. will manufacture and sell this line of pumps in the future under their own name.

$1,000.00

IN PRIZES FOR WATER WORKS SUPERINTENDENTS ENGINEERS, CONTRACTORS

CLOW-NATIONAL $1,000.00 "A Better Pipe Economy" CONTEST

How would you like to get a nice big, juicy check on December 11, 1940—just in time for Christmas?
You can make this possible by writing TODAY for the completely informative Contest Folder entitled "You May Have A Prize-Winning Idea."
Address: Frank J. Egan, Manager Cast Iron Pipe and Foundry Dept.

JAMES B. CLOW & SONS
201-299 North Talman Avenue
CHICAGO, ILLINOIS

Sewage Gas, Gasoline, Butane and Diesel engines.

●

Generator sets for stand-by or continuous duty service.

●

Gasoline engines to meet Fire Underwriters' requirements.

Lawrence Stahl & Co., Inc.
21 Morris Street, New York, N. Y.

WILSON CHEMICAL FEEDER

Outstanding features are quick feed adjustment, visible valves, flexible cylinders; feeds against 150-lb. pressure, and proof against corrosive chemicals.

Motor driven, positive displacement, pump type feeder. It is illustrated as a constant rate feeder though also furnished as Type MD-H with fluid meter control, and when so arranged is a measure-to-measure proportioning feeder.

This is a sturdy, dependable heavy duty feeder.

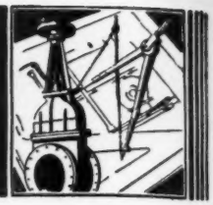
Write for Bulletin

Wilson Chemical Feeders, Inc.
BUFFALO, NEW YORK

Consulting Engineers

Specializing in the field of

WATER WORKS & SEWERAGE



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Consulting Engineers

Water, Sewerage, Industrial Waste, Garbage, Power Plant and Valuation Problems.

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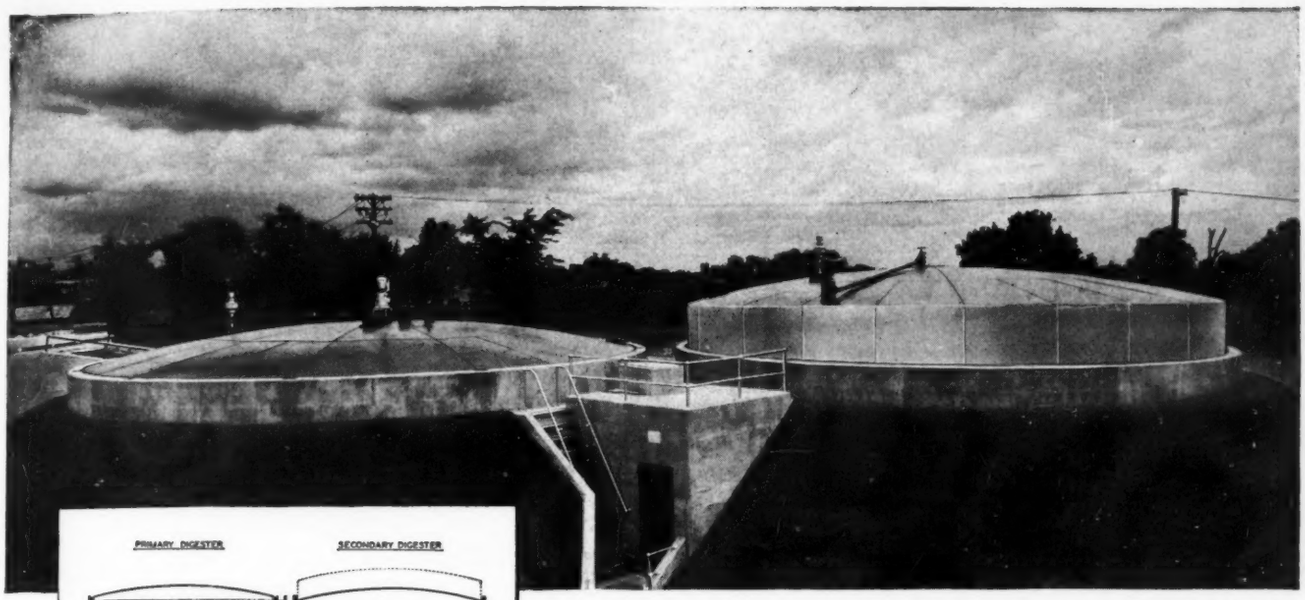

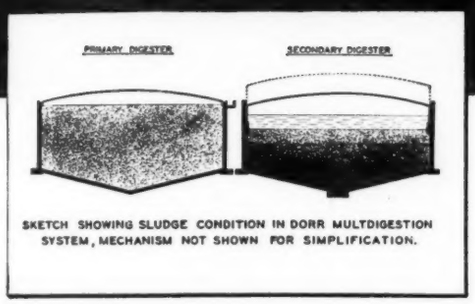

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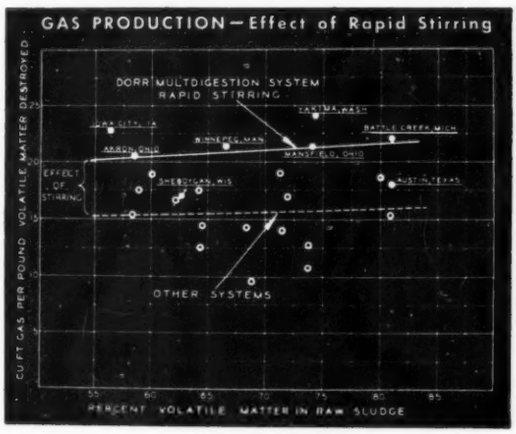
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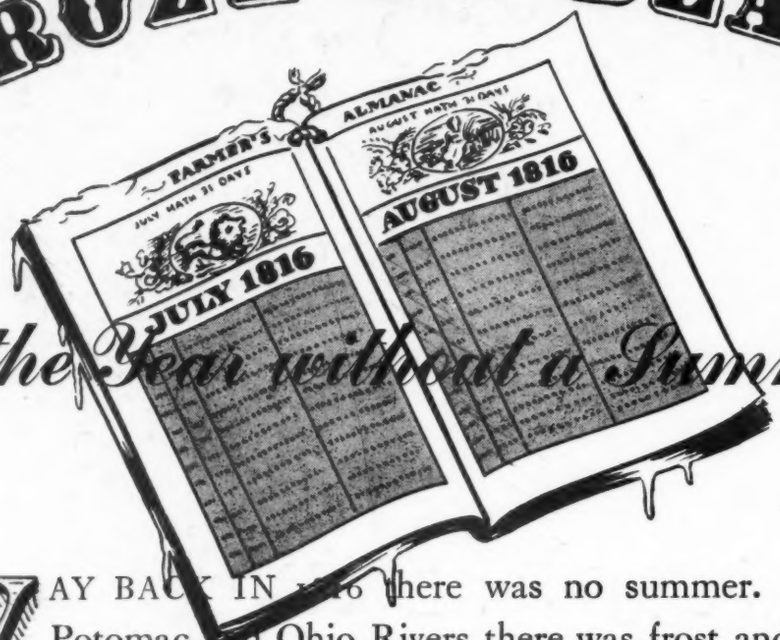

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